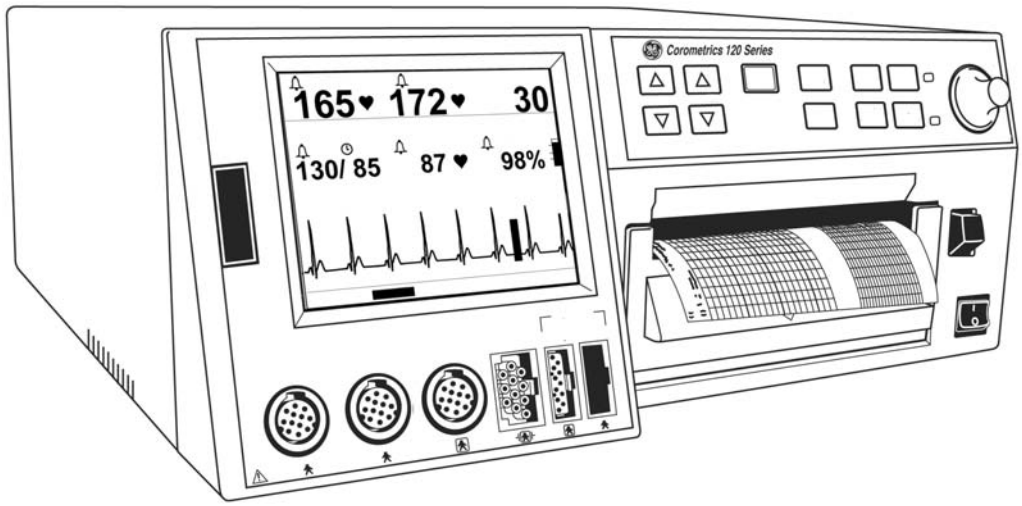
Corometrics® 120 Series V3.5

SERVICE MANUAL

MANUAL P/N 2015590-001 REV. B



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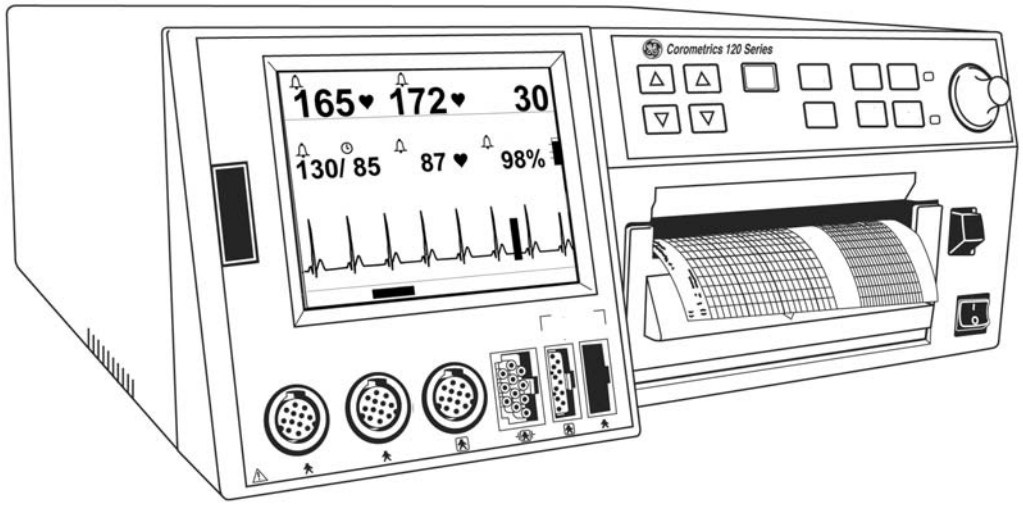

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All equipment sold by GE Medical Systems *Information Technologies*, is fully guaranteed as to materials and workmanship for a period of 1 year. *GE* reserves the right to perform guarantee service operations in its own factory, at an authorized repair station, or in the customer's installation.

Our obligation under this guarantee is limited to repairing, or, at our option, replacing any defective parts of our equipment, except fuses or batteries, without charge, if such defects occur in normal service.

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GE Medical Systems *Information Technologies* will make available on request such circuit diagrams, component diagrams, component parts lists, descriptions, calibration instructions, or other information which will assist the users or appropriately qualified technical personnel to repair those parts of the equipment which are classified by *GE* as repairable.

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Compliance

This monitor bears the CE Mark indicating its conformity with the provisions of the Council Directive 93/42/EEC concerning medical devices.

Components of the Certified Systems

The IEC electromagnetic compatibility (EN) standards require individual equipment (components and accessories) to be configured as a system for evaluation. For systems that include a number of different equipments that perform a number of functions, one of each type of equipment shall be included in the evaluation.

The equipment listed below is representative of all possible combinations. For individual equipment certification, refer to the appropriate declarations of conformity.

Component Description

120 Series Maternal/Fetal Monitor
Model 146 Fetal Acoustic Stimulator
Intrauterine Pressure Transducer
FECG Cable/Legplate
Ultrasound Transducers (x2)
Blood Pressure Hose and Cuff
$MSpO_2$ Interconnect Cable and Sensor
MECG Cable
FECG/MECG Adapter Cable
Remote Event Marker
RS-232C Interconnect Cables (x3)
COROLAN Interconnect Cable
Central Nurses Station Interconnect Cable
Model 2116B Interconnect Cable

Exceptions

None

Monitor System EMC: Immunity Performance

Be aware that adding accessories or components, or modifying the medical device or system may degrade the EMI performance. Consult with qualified personnel regarding changes to the system configuration.

CE
0459

For Your Notes

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Chapter 1

⚠ Safety

The information presented in this section is important for the safety of both the patient and operator. This chapter describes how the terms Danger, Warning, Caution, Important, and Note are used throughout the manual. In addition, standard equipment symbols are defined.

This section includes the following important information:

General Information 1-2
Definitions of Terminology 1-3
Monitor Contraindications, Warnings, and Precautions 1-4
Equipment Symbols 1-9

General Information

General Use

If the monitor is cold to the touch or below ambient temperature, allow it to reach ambient, room temperature before use.

To ensure patient safety, use only parts and accessories manufactured or recommended by GE Medical Systems *Information Technologies*. Parts and accessories used shall meet the requirements of EN60601.1.1.

Disposable devices are intended for single use only. They should not be reused.

Periodically, and whenever the integrity of the monitor is in doubt, test all functions. Refer to "Chapter 6, Functional Checkout Procedure".

Refer to the "Maternal/Fetal Monitoring Operator's Manual" for information concerning the limitations of internal and external fetal heart rate monitoring techniques.

Responsibility of the Manufacturer

GE is responsible for the effects on safety, reliability, and performance if:

- assembly operations, extensions, readjustments, modifications, or repairs are carried out by persons authorized by GE;
- the electrical installation of the relevant room complies with the requirements of appropriate regulations; and
- the monitor is used in accordance with the instructions of use.

Responsibility of the User

This device is intended for use by clinical professionals who are expected to know the medical procedures, practices, and terminology required to monitor obstetrical patients. This manual documents all possible parameters available in the 120 Series of monitors. It is the responsibility of each hospital to ensure that the Labor and Delivery staff is trained in all aspects of the selected model.

The 120 Series Monitor is designed to assist the perinatal staff by providing information regarding the clinical status of the mother and fetus during labor. The monitor does not replace observation and evaluation of the mother and fetus at regular intervals, by a qualified care provider, who will make diagnoses and decide on treatments or interventions. Visual assessment of the monitor display and strip chart must be combined with knowledge of patient history and risk factors to properly care for the mother and fetus.

Definitions of Terminology

Six types of special notices are used throughout this manual. They are: Danger, Warning, Caution, Contraindication, Important, and Note. The warnings and cautions in this Safety section relate to the equipment in general and apply to all aspects of the monitor. Be sure to read the other chapters because there are additional warnings and cautions which relate to specific features of the monitor.

When grouped, warnings and cautions are listed alphabetically and do not imply any order of importance.

Table 1-1. Definitions of Terminology

Danger	A DANGER notice indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.
Warning	A WARNING indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.
Caution	A CAUTION indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury. Cautions are also used to avoid damage to equipment.
Contraindication	A CONTRAINDICATION describes any special symptom or circumstance that renders the use of a remedy or the carrying out of a procedure inadvisable, usually because of a risk.
Important	An IMPORTANT notice indicates an emphasized note. It is something you should be particularly aware of; something not readily apparent.
Note	A NOTE indicates a particular point of information; something on which to focus your attention.

Monitor Contraindications, Warnings, and Precautions

Warnings

WARNINGS

ACCIDENTAL SPILLS—In the event that fluids are accidentally spilled on the monitor, take the monitor out of operation, clean, and inspect for damage.

APPLICATION—This monitor is not designed for direct cardiac connection.

CONDUCTIVE CONNECTIONS—Avoid making any conductive connections to applied parts (patient connection) which are likely to degrade safety.

CONDUCTIVE PARTS—Ensure that the conductive parts of the lead electrodes and associated connectors do not contact other conductive parts including earth.

CONNECTIONS—The correct way to connect a patient to the monitor is to plug the ***electrode leads*** into the ***patient cable*** which in turn connects to the ***monitor***. The ***monitor*** is connected to the ***wall socket*** by the ***power cord***. Do ***not*** plug the electrode leads into the power cord, a wall socket, or an extension cord.

DEFIBRILLATION—During defibrillation, all personnel must avoid contact with the patient and monitor to avoid a dangerous shock hazard. In addition, proper placement of the paddles in relation to the electrodes is required to minimize harm to the patient.

ELECTRICAL SHOCK—To reduce the risk of electrical shock, do not remove monitor cover. Refer servicing to qualified personnel.

ELECTROMAGNETIC INTERFERENCE—Be aware that strong electromagnetic fields may interfere with monitor operation. Interference prevents the clear reception of signals by the monitor. If the hospital is close to a strong transmitter such as TV, AM or FM radio, police or fire stations, a HAM radio operator, an airport, or cellular phone, their signals could be picked up as signals by the monitor. If you feel interference is affecting the monitor, contact your Service Representative to check the monitor in your environment. Refer to page 1-8 for additional information.

WARNINGS

ELECTROSURGERY—The monitor is not designed for use with high-frequency surgical devices. In addition, measurements may be affected in the presence of strong electromagnetic sources such as electrosurgery equipment.

EXPLOSION HAZARD—Do not use this equipment in the presence of flammable anesthetics or contained oxygen.

GROUNDING—Do not defeat the three-wire grounding feature of the power cord by means of adaptors, plug modifications, or other methods. A dangerous shock hazard to both patient and operator may result.

INSTRUCTIONS—For continued and safe use of this equipment, it is necessary to follow all listed instructions. However, the instructions provided in this manual in no way supersede established medical procedures concerning patient care. The monitor does not replace observation and evaluation of the patient, at regular intervals, by a qualified care provider who will make diagnoses and decide on treatments and interventions.

INTERFACING OTHER EQUIPMENT—Monitoring equipment must be interfaced with other types of medical equipment by qualified biomedical engineering personnel. Be certain to consult manufacturers' specifications to maintain safe operation.

LEAKAGE CURRENT TEST—The interconnection of auxiliary equipment with this device may increase the total leakage current. When interfacing with other equipment, a test for leakage current must be performed by qualified biomedical engineering personnel before using with patients. Serious injury or death could result if the leakage current exceeds applicable standards. The use of accessory equipment not complying with the equivalent safety requirements of this equipment may lead to a reduced level of safety of the resulting system. Consideration relating to the choice shall include: use of the accessory in the patient vicinity; and evidence that the safety certification of the accessory has been performed in accordance with the appropriate EN60601.1 and/or EN60601.1.1 harmonized national standard.

WARNINGS

LINE ISOLATION MONITOR TRANSIENTS—Line isolation monitor transients may resemble actual cardiac waveforms, and thus cause incorrect heart rate determinations and alarm activation (or inhibition).

MRI USE—Do not use the electrodes during MRI scanning; conducted current could potentially cause burns.

PATIENT CABLES AND LEADWIRES—Do not use patient cables and electrode leads that permit direct connection to electrical sources. Use only “safety” cables and leadwires. Use of non-safety patient cables and lead wires creates risk of inappropriate electrical connection which may cause patient shock or death.

PACEMAKER PATIENTS—Rate meters may continue to count the pacemaker rate during occurrences of cardiac arrest or some arrhythmias. Do not rely entirely upon rate meter alarms. Keep pacemaker patients under close surveillance. Refer to “Chapter 13, Technical Specifications” for disclosure of the pacemaker pulse rejection capability of the 120 Series Monitor.

SIMULTANEOUS DEVICES—Do not simultaneously connect more than one device that uses electrodes to detect ECG and/or respiration to the same patient. Use of more than one device in this manner may cause improper operation of one or more of the devices.

STRANGULATION—Make sure all patient cables, leadwires, and tubing are positioned away from the patient’s head to minimize the risk of accidental strangulation.

WATER BIRTHS—Do not use the monitor to directly monitor patients during water births, in whirlpool or submersion water baths, during showers, or in any other situation where the mother is immersed in water. Doing so may result in electrical shock hazard. For immersed and wet environment monitoring, refer to Corometrics 340 Telemetry System Operator’s Manual (P/N 2006899-001) and Corometrics 340 Telemetry System Service Manual (P/N 2006920-001).

Cautions

CAUTIONS

ANNUAL SERVICING—For continued safety and performance of the monitor, verify the calibration, accuracy, and electrical safety of the monitor annually. Contact your GE Service Representative for further information.

DAILY TESTING—It is essential that the monitor and accessories be inspected every day. It is recommended practice to initiate the monitor's self-test feature at the beginning of each monitoring session; follow the instructions in "Chapter 5, Setup Procedures".

ENVIRONMENT—The performance of the monitor has not been tested in certain areas, such as x-ray and imaging suites. The monitor is not recommended for use in these environments.

PERFORMANCE—Report all problems experienced with the monitor. If the monitor is not working properly, contact your Service Representative for service. The monitor should not be used if it is not working properly.

PINCHING—Keep fingers clear of the paper roller because the roller could pinch your fingers.

TRAPPING—Keep hands, hair, jewelry, and loose clothing away from the paper roller because the roller could trap these items.

TRIPPING—Arrange monitoring equipment so that cords and cables do not present a tripping hazard.

Electromagnetic Interference

This device has been tested and found to comply with the limits for medical devices to the IEC 601-1-2:1993, EN60601-1-2:1994, Medical Device Directive 93/42/EEC. These limits are designed to provide reasonable protection against harmful interference in a typical medical installation.

However, because of the proliferation of radio-frequency transmitting equipment and other sources of electrical noise in the health-care and home environments (for example, cellular phones, mobile two-way radios, electrical appliances), it is possible that high levels of such interference due to close proximity or strength of a source, may result in disruption of performance of this device.

This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with these instructions, may cause harmful interference with other devices in the vicinity. Disruption or interference may be evidences by erratic readings, cessation of operation, or incorrect functioning. If this occurs, the site of use should be surveyed to determine the source of this disruption, and actions taken to eliminate the source.

The user is encouraged to try to correct the interference by one or more of the following measures:

- Turn equipment in the vicinity off and on to isolate the offending equipment.
- Reorient or relocate the other receiving device.
- Increase the separation between the interfering equipment and this equipment.
- If assistance is required, contact your GE Service Representative.

Equipment Symbols

The following is a list of symbols used on products manufactured by GE. Some symbols may not appear on your unit.

Table 1-2. Equipment Symbols	
	ATTENTION: Consult accompanying documents.
	TYPE B EQUIPMENT. Type B equipment is suitable for intentional external and internal application to the patient, excluding direct cardiac application.
	TYPE BF EQUIPMENT. Type BF equipment is suitable for intentional external and internal application to the patient, excluding direct cardiac application. Type BF equipment has an F-type applied part.
	DEFIBRILLATOR-PROOF TYPE BF EQUIPMENT: Type BF equipment is suitable for intentional external and internal application to the patient, excluding direct cardiac application. Type BF equipment is type B equipment with an F-type isolated (floating) part. The paddles indicate the equipment is defibrillator proof.
	ALTERNATING CURRENT (AC).
	EQUIPOTENTIALITY.
O	POWER OFF: disconnection from the mains.
I	POWER ON: connection to the mains.

For your notes

Chapter 2

Introduction

This section lists the indications for use for maternal/fetal monitors in the Corometrics 120 Series. The Corometrics 120 Series is extremely flexible, allowing you to mix and match features.

This section provides information about your monitor in relation to this manual, as well as the intended uses of the device:

Indications for Use 2-2
Series Overview 2-3
About the Manual 2-7

Indications for Use

Fetal Monitoring

A Corometrics 120 Series Monitor can be used for routine non-invasive and invasive fetal monitoring throughout labor and delivery (i.e. fetal heart rate and uterine activity monitoring) Fetal movement detection and fetal heart rate alarm options (user selectable high/low and poor signal quality alarms) are available.

Maternal Monitoring

A Corometrics Model 128 or 129 Maternal/Fetal Monitor is intended for monitoring maternal vital signs to help assess maternal well-being. The vital signs which can be measured with either of these monitors are summarized below.

IMPORTANT– Maternal vital signs provided by the monitor should only be used as an adjunct to patient assessment and must be used in conjunction with clinical signs and symptoms.

Blood Pressure

This parameter is intended for use in the non-invasive monitoring of maternal blood pressure (NBP). This monitor is not intended for use in neonatal or pediatric blood pressure monitoring.

Pulse Oximetry

This parameter is intended for use in the non-invasive monitoring of the functional oxygen saturation of maternal arterial blood ($MSpO_2$).

Heart/Pulse Rate

NOTE: A Model 128 provides maternal *pulse* rate data derived from the NBP and $MSpO_2$ sections of the monitor. Only a Model 129 provides both maternal *heart* rate and maternal *pulse* rate data; the *heart* rate data is derived from the MECG section of the monitor while the *pulse* rate data is derived from the NBP and $MSpO_2$ sections of the monitor.

This parameter is intended for use in the non-invasive monitoring of the maternal heart/pulse rate (MHR/P).

Series Overview

The Model 126 Monitor

The Model 126 Monitor provides standard fetal monitoring parameters—dual ultrasound, fetal ECG, and uterine activity. The Model 126 has the following features:

- Dual ultrasonic heart rate monitoring allows for non-invasive monitoring of twins.
- A +20 BPM heart rate offset option is provided for the secondary heart rate (HR2) trend, when using dual ultrasound, or ultrasound and direct FECG, to separate overlapping FHR trends for easy interpretation.
- A heartbeat coincidence detection feature can be enabled to inform you when there is the possibility that you may be monitoring a duplicate signal.
- The electroluminescent (EL) display, with circularly polarized filter, removes glare; its wide viewing angle provides easy viewing at a distance.
- The strip chart recorder is a quiet, easy-to-load, high-resolution thermal array printer. The recorder prints continuous trends and alphanumeric data on one strip chart.
- User-selectable font size for strip chart annotations customizes readability.
- Automatic mode selection is provided simply by inserting the appropriate transducer plug into the front panel receptacle.
- The ChartLight allows the room lights to be dimmed without sacrificing visibility of the strip chart recorder.
- Transducer connectors are easy-to-use, color-coded, and durable.
- Frequently used functions are controlled by your choice of front panel monitor buttons—audio volume, UA reference, alarm silence, event mark, record, and paper advance.
- System setup options are easily accessed via a front panel Trim Knob control.
- Fetal parameters are continuously displayed even during configuration of system setup options.
- Annotations from an optional Model 2116B Keyboard are printed on the strip chart recorder paper.
- The ultrasound mode provides clean accurate traces with few “dropouts” because of Corometrics’ patented autocorrelation processing.
- Fetal heart rate alarm limits are user-defined, with pre-set defaults. Signal quality has no user-defined parameters.
- Alarm limits are easily configured via setup screens.
- Alarm silencing is controlled by a front panel monitor button which is brightly colored for easy recognition.

- Alarm conditions have audible and visual indications. Audible alarms can be disabled. Fetal heart rate threshold and signal quality alarms can be cancelled.
- The monitor can be interfaced to the most widely used non-invasive blood pressure monitors and pulse oximeters.
- The FECG waveform can be optionally displayed and can be “frozen” on the screen for review. In addition, a six-second “snapshot” can be printed on the strip chart paper.

The Model 128 Monitor

The Model 128 Monitor provides all of the features of the Model 126 Monitor with the addition of integrated maternal pulse oximetry and non-invasive blood pressure monitoring, plus the following:

- Built-in maternal vital signs monitoring eliminates the need for separate blood pressure and maternal pulse oximetry monitors.
- Maternal non-invasive blood pressure* readings can be taken on-demand or at pre-programmed intervals using the well-known DINAMAP blood pressure technology.
- Smart BP option prevents blood pressure readings from occurring during contractions.
- Continuous non-invasive $MSpO_2$ oxygen saturation and maternal pulse rate can be reliably monitored using the well-known Nellcor pulse oximetry brand.
- Continuous display/printing of the maternal pulse rate trend can be enabled.
- Maternal alarm limits are user-defined, with pre-set defaults.
- The audible indicator for each maternal alarm can be temporarily silenced.
- Maternal vital signs storage provides an eight-hour history of the maternal vital signs in a spreadsheet format. The data can be displayed or printed on-demand.
- A maternal-only recording mode is specifically designed for postpartum monitoring of the mother.
- The $MSpO_2$ pulsatile waveform can be optionally displayed and can be "frozen" on the screen for review. In addition, a six-second "snapshot" can be printed on the strip chart paper.

* *Blood pressure is not automatically activated. Manual blood pressure readings must be started via a front panel monitor button or display button. Automatic readings must be initiated via a setup window.*

The Model 129 Monitor

The Model 129 has all of the features of the Model 128, plus the following:

- Built-in independent MECG monitoring is provided with selection of lead I, II, or III.
- Twins *and* maternal monitoring can be accomplished simultaneously using dual ultrasound *and* MECG; or using ultrasound, FECG, *and* MECG.
- The MECG waveform can be optionally displayed and can be "frozen" on the screen for review. In addition, a six-second snapshot can be printed on the strip chart paper.
- The large display shows fetal parameters, maternal parameters, and one waveform all at once.

Upgrading Your Monitor

The 120 Series family of monitors provides one solution for high-risk and low-risk labors and deliveries. The 120 Series of monitors lets you start with a basic monitor and add the extended and/or more advanced features later as your clinical needs increase and your budget allows. Refer to Chapter 12, "Upgrading a 120 Series Monitor" , for more information.

Adding Fetal Movement Detection

Each monitor in the series can be upgraded to include fetal movement detection (FMD). Contact your Service Representative for more information.

About the Manual

Purpose

This manual documents all possible parameters so that when you upgrade you will not require any new documentation. The manual also provides an opportunity to read about features you may not have to assist you with your upgrade decisions. Some sections will not apply if your monitor is not equipped with $MSpO_2$, maternal NBP, MECG, or $FSpO_2$ monitoring capabilities. Table 2-1 provides a summary of the 120 Series family of monitors.

Table 2-1. Summary of Monitoring Modes

Parameter	120 Series[a] Model		
	126	128	129
US	✓	✓	✓
US2	✓	✓	✓
FECG	✓	✓	✓
TOCO	✓	✓	✓
IUP	✓	✓	✓
NBP		✓	✓
$MSpO_2$		✓	✓
MECG			✓

[a] *The F-Series adds $FSpO_2$.*

Intended Audience

This manual is intended for trained service professionals.

Illustrations

All illustrations are provided as examples only. Your monitor may not be equipped with all of the features shown. In addition, unless explicitly stated, the screen examples do not represent your equipment setup or displayed data.

Design Changes

Due to design changes associated with continuing product improvements, information in this manual is subject to change. GE Medical Systems *Information Technologies* reserves the right to change software/hardware design at any time and any such changes could affect the contents of the manual. GE assumes no responsibility for any errors or inconsistencies appearing in this manual that result from product design changes and upgrades.

References to Persons, Places, and Institutions

References to persons, places, and institutions used within this manual are solely intended to facilitate user comprehension of the 120 Series Monitor's use and functions. Extreme care has been taken to use fictitious names and related information in the examples and illustrations provided herein. Any similarity of this data to persons either living or dead and to either current or previously existing medical institutions should be regarded as coincidental.

Chapter 3

Controls, Indicators, and Connectors

This section describes all possible controls, indicators, and connectors in the 120 Series of monitors.

The section contains the following:

Front Panel Description 3-2
Front Panel Displays 3-5
Rear Panel Description. 3-17

Front Panel Description

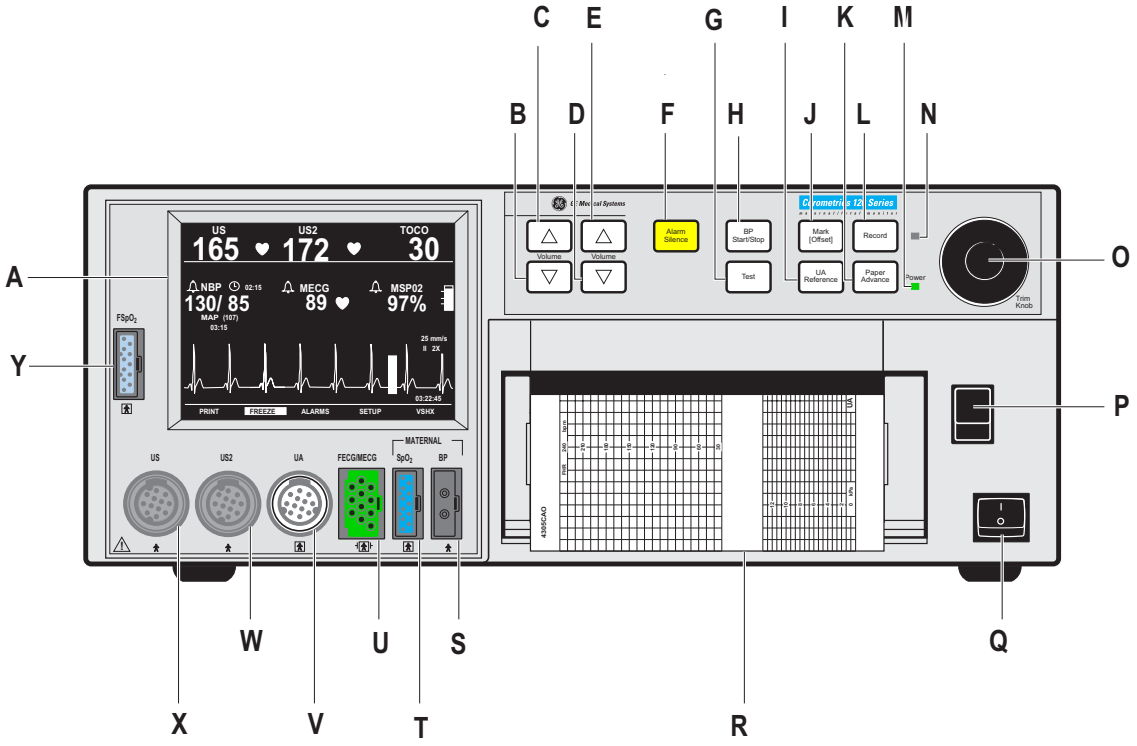


Figure 3-1. Model 129 Front Panel

Table 3-1. Model 129 Front Panel

#	Name	Description
A	Display	The monitor's display is divided into several sections. The content and layout of the display can change, depending on which functions are installed in the monitor and the modes of operation in use.
B	FHR1 Volume Decrease Button	The four Volume buttons raise (△) and lower (▽) the volume of sound emitted by the rear panel speaker. The left pair controls the volume for FHR1. The right pair controls the volume for FHR2. Volume settings have no effect on the processing used to determine heart rate. The volume buttons work in conjunction with the volume control settings on the US/US2 Setup screen (page 5-9) and on the FECG Setup screen (page 5-8).
C	FHR1 Volume Increase Button	
D	FHR2 Volume Decrease Button	
E	FHR2 Volume Increase Button	
F	Alarm Silence Button	Pressing this button removes the audible indication of an individual alarm.
G	Test Button	Pressing and holding this button for one second starts or stops a monitor self-test routine.
H	BP Start/Stop Button	This button starts and stops both manual and automatic blood pressure determinations. It also provides a "shortcut" for changing the auto interval time.
I	UA Reference Button	The UA Reference button sets a baseline for uterine activity pressure monitoring.
J	Mark [Offset] Button	The Mark (Offset) pushbutton is a multi-function pushbutton. ■ Mark: Pressing this button prints an event mark ↑ on strip chart paper (on the bottom two lines of the top grid). ■ Offset: When the Heart Rate Offset mode is enabled, pressing and *holding* this button shifts the secondary FHR trend +20 BPM for visibility purposes.
K	Paper Advance Button	Pressing this button advances chart paper at a rate of 40 cm/min for as long as the button is held down.
L	Record Button	The Record button selects one of three recorder states: on, maternal-only mode, or off.
M	Power Indicator	The indicator lights green when the monitor is turned on.
N	Record Indicator	Indicator Status / Recorder Status on / on off / off flickers / maternal-only mode flashing / error condition
O	Trim Knob Control	Operation of the monitor is controlled by using the front panel pushbuttons in conjunction with the Trim Knob control. This control selects softkeys on the display and positions a cursor within a setup screen. Rotate the Trim Knob control left or right to highlight items on the screen with a bar cursor. After highlighting the desired item, press the Trim Knob control to make the selection. In summary: rotate to move cursor; press to select an item.
P	Recorder Door Latch	Opens the strip chart recorder door to add, remove, or adjust the paper.
Q	Power Switch	Moving the switch to the *on* position (I) turns on the monitor; moving the switch to the *off* position (O) turns off the monitor.
R	Strip Chart Recorder	Annotations and trends are printed on the strip chart paper. Two paper styles are available. Refer to "Chapter 5, Setup Procedures" , for instructions on loading strip chart paper into the recorder.

Table 3-1. Model 129 Front Panel		
#	Name	Description
S	Maternal NBP Connector	Connect a pneumatic hose and blood pressure cuff assembly to this black twin lumen receptacle.
T	Maternal SpO_2 Connector	Connect a 120 Series $MSpO_2$ intermediate cable to this royal blue receptacle. Use only Nellcor cables if you have Nellcor technology installed and only Masimo cables if you have Masimo technology installed in your monitor.
U	FECG or FECG/MECG Connector	Connect an FECG or MECG cable plug to this green receptacle. For Models 126 or 128, the connector is labeled FECG. For a Model 129, the connector is labeled FECG/MECG. Cables with *rectangular* plugs connect directly to the FECG/MECG receptacle. Cables with *round* plugs require an FECG/MECG adapter, cat. no. (REF) 1442AAO. Use this adapter for dual ECG monitoring as well. The adapter branches into two cables, each with a *round* receptacle at the end: one branch is labeled MECG; the other branch is labeled FECG.
V	UA Connector	Connect a tocotransducer, IUPC, or strain gauge transducer plug to this white receptacle Contact your Sales Representative for information about compatibility.
W	US2 Connector	Connect the secondary ultrasound transducer plug to this light gray receptacle.
X	US Connector	Connect the primary ultrasound transducer plug to this light gray receptacle.
Y	Fetal SpO_2 Connector	Connect a 120 Series Fetal Patient Module cable to this light blue receptacle. Use only Nellcor OxiFirst Fetal Oxygen Sensors (Series FS14).

Front Panel Displays

The monitor's display is divided into five horizontal sections. The content and layout of the display can change, depending on which functions are installed in the monitor and the modes of operation in use.

Table 3-2. Display Summary

Display Section	Item	Mode
Primary Labor Parameters	Fetal Heart Rate 1 (FHR1)	US, US2, FECG, or INOP
	Fetal Heart Rate 2 (FHR2)	US, US2, or INOP
	Uterine Activity (UA)	TOCO, IUP, or INOP
Additional Parameters	Maternal Blood Pressure	NBP
	Maternal Heart/Pulse Rate	MECG or PULSE
	Fetal or Maternal SpO_2	%$FSpO_2$ or %$MSpO_2$
Waveform	Fetal ECG Waveform; Maternal ECG Waveform; Fetal SpO_2 Pulsatile Waveform; or Maternal SpO_2 Pulsatile Waveform	FECG, MECG, $FSpO_2$, $MSpO_2$, or OFF
Time	Current Time; [LABEL] FROZEN Message, and Time of Activation	—
Softkeys	System Configuration Softkey Controls	—

Display Example

Figure 3-2, "Model 129 Display Example," on page 3-6, provides an example of a Model 129 display. In this example:

- Blood pressure is not active as indicated by the absence of numerics.
- Maternal pulse oximetry is active.
- MECG is selected as the heart rates source as indicated by the MECG mode title softkey—rather than PULSE.
- The MECG waveform is displayed at 25 mm/sec, at a size of 2X, with lead II selected.
- Heartbeat coincidence is enabled as indicated by the HBC acronym in the primary labor parameters area.
- All alarms are enabled as indicated by .

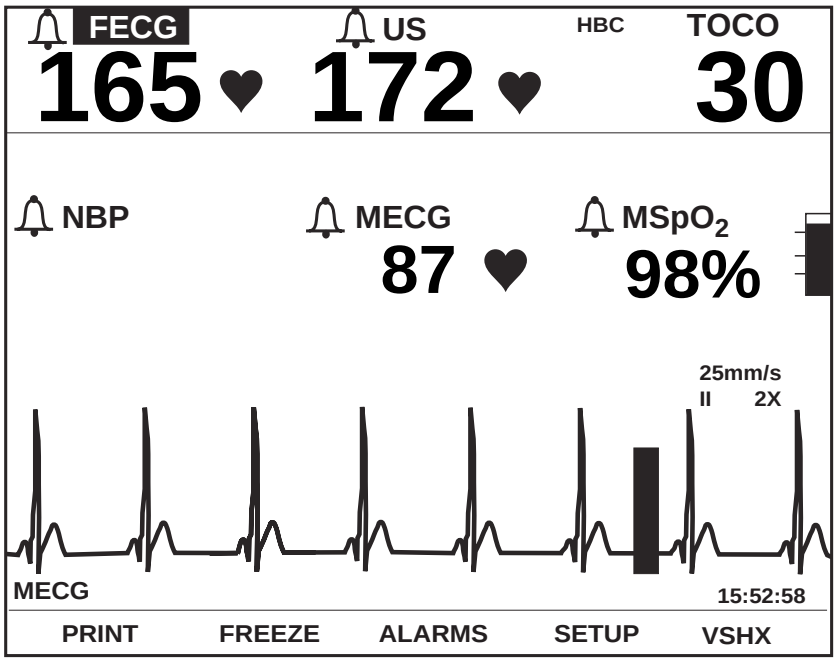


Figure 3-2. Model 129 Display Example

The Model 126 has a unique feature which automatically centers the primary fetal parameters in the display when no waveform is active. See figure below.

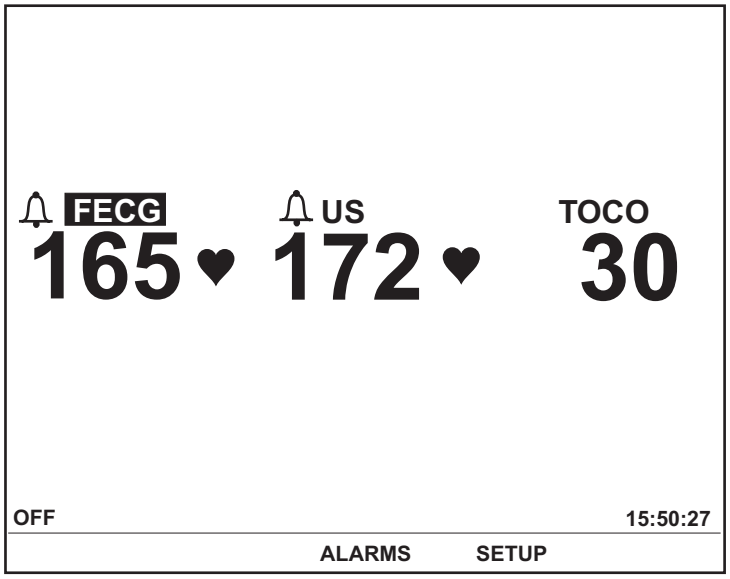


Figure 3-3. Model 126 Display

Primary Labor Parameters

The primary labor parameters section displays FHR1, FHR2, and UA data.

FHR Display

The FHR1 and FHR 2 areas are summarized by Figure 3-4 and Table 3-3.

Figure 3-4. FHR Display

Table 3-3. FHR Display

	Name	Description
A	FHR Value	Up to three digits indicate the fetal heart rate in beats per minute.
B	FHR Alarm Setting Indicator	This symbol provides information about the FHR audio alarm *and* the FHR high/low alarm limit settings. ■ : An alarm setting is turned off. ■ : All alarm settings are enabled.
C	FHR Mode Title	An abbreviation indicates the monitoring mode in use: FECG, US, US2, or INOP. (FECG only displays in the FHR1 area.) Select the mode softkey to access the respective setup screen. See Table 3-4 for FHR connection options.
D	FHR Heartbeat Indicator	Flashes with each detected valid heartbeat.

Table 3-4. Connectors vs. Display Modes			
Active Connectors		FHR1 Area	FHR2 Area
FECG		FECG	INOP
FECG/US		FECG	US
FECG/US2		FECG	US2
US		US	INOP
US/US2		US	US2
US2		US2	INOP
—		INOP	INOP
FECG/US/US2[a]		FECG	US2

[a] *If three FHR transducers are plugged in, the FECG signal overrides the US signal.*

UA Display

The UA area is summarized by Figure 3-5 and Table 3-5.

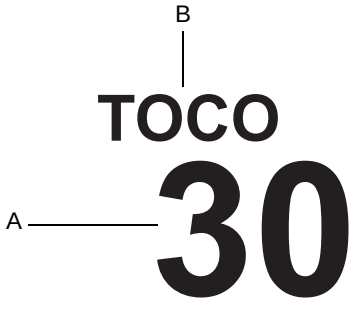


Figure 3-5. UA Display

Table 3-5. UA Display

	Name	Description
A	UA Value	Up to three digits indicate the uterine activity value—mmHg for internal monitoring or relative units for external monitoring.
B	UA Mode Title	An abbreviation indicates the monitoring mode in use: TOCO, IUP, or INOP.

Additional Parameters

The additional parameters area displays NBP, MHR/P, and MSpO2 data.

Maternal NBP

The maternal NBP section is summarized by Figure 3-6 and Table 3-6.

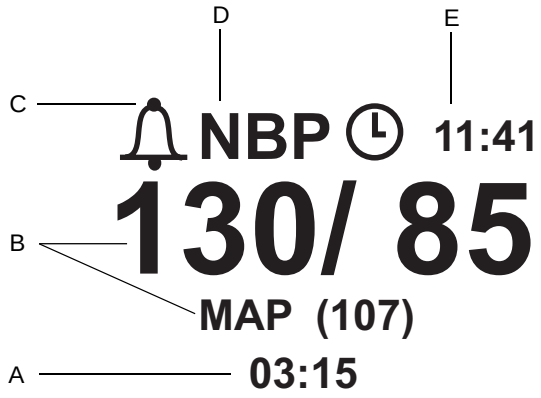


Figure 3-6. NBP Display

Table 3-6. NBP Display		
	Name	Description
A	NBP Time Stamp	The time (in 24-hour format) of the last blood pressure measurement.
B	NBP Values	The systolic/diastolic and mean arterial pressures (MAP) are each indicated by up to three digits—representing mmHg. During a determination, the instantaneous cuff pressure displays in place of the mean arterial pressure and is denoted by the title CUFF.
C	NBP Alarm Setting Indicator	This symbol provides information about the NBP audio alarm ***and*** the NBP high/low alarm limit settings. ■ : An alarm setting is turned off. ■ : All alarm settings are enabled.
D	NBP Mode Title	Select the mode title to access the NBP Setup screen.
E	NBP Countdown Timer	The clock symbol represents activation of the auto mode. The countdown timer indicates the minutes and seconds until the next automatic reading.

MHR/P Area

The MHR/P area is summarized by Figure 3-7 and Table 3-7.

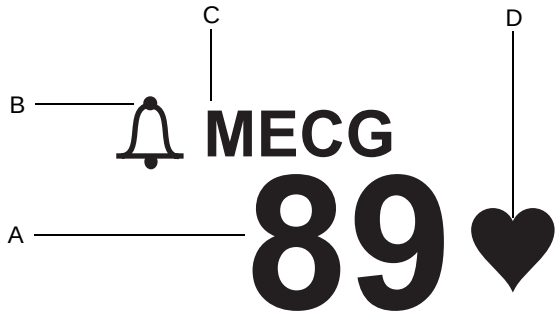


Figure 3-7. MHR/P Display

Table 3-7. MHR/P Display

	Name	Description
A	MHR/P Value	Up to three-digits indicate the MHR/P in beats per minute.
B	MHR/P Alarm Setting Indicator	This symbol provides information about the MHR/P audio alarm *and* the MHR/P high/low alarm limit settings. ■ : An alarm setting is turned off. ■ : All alarm settings are enabled.
C	MHR/P Mode Title	The mode title MECG indicates MECG is the MHR/P source; the mode title PULSE indicates $MSpO_2$ or NBP is used as the source. Select the mode title softkey to access the MHR/P Setup screen.
D	Maternal Heartbeat Indicator	Flashes with each detected valid heartbeat—for MECG only.

$FSpO_2$ Area

The $FSpO_2$ area is summarized by Figure 3-8 and Table 3-8.

IMPORTANT

If $FSpO_2$ is monitored while $MSpO_2$ is inactive, $FSpO_2$ displays in the Additional Parameters Area. When dual SpO_2 monitoring occurs, $FSpO_2$ information is displayed in the Waveform Area beneath the $MSpO_2$ area.

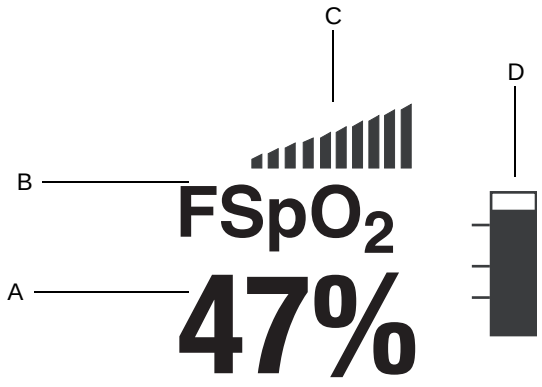


Figure 3-8. $FSpO_2$ Display

Table 3-8. $FSpO_2$ Display

	Name	Description
A	$FSpO_2$ Value	This three-digit display indicates the $FSpO_2$ level calculated form qualified optical pulses.
B	$FSpO_2$ Mode Title	The $FSpO_2$ title indicates that *fetal* oxygen saturation monitoring is in progress.
C	Signal Quality Indicator	This indicator shows the average signal quality of pulses being detected at the sensor site according to a software algorithm in the 120 F-Series Monitor. The presence of all ten bars represents fetal pulses with consistently high signal quality for $FSpO_2$ measurement. Fewer bars represents diminished signal quality. The absence of bars represents a lack of fetal pulses with acceptable signal quality.
D	Pulse Amplitude Indicator	This vertical bar qualitatively indicates pulse amplitude at the sensor site.

$MSpO_2$ Area

The $MSpO_2$ area is summarized by Figure 3-9 and Table 3-9.

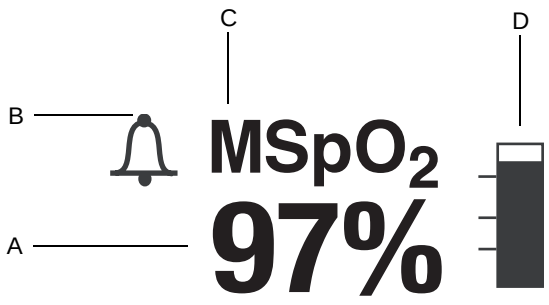


Figure 3-9. $MSpO_2$ Display

Table 3-9. $MSpO_2$ Display

	Name	Description
A	$MSpO_2$ Value	Up to three digits indicate the percentage of oxygen in the mother's blood.
B	$MSpO_2$ Alarm Setting Indicator	This symbol provides information about the $MSpO_2$ audio alarm ***and*** the $MSpO_2$ high/low alarm limit settings. ■ : An alarm setting is turned off. ■ : All alarm settings are enabled.
C	$MSpO_2$ Mode Title	Select the mode title to access the $MSpO_2$ Setup screen.
D	$MSpO_2$ Pulse Amplitude Indicator	This vertical bar qualitatively indicates pulse amplitude.

Waveform Area

The waveform area displays approximately four seconds of waveform data for: FECG, MECG, $FSpO_2$ or $MSpO_2$.

Time and Waveform Message Area

The current time (in 24-hour format) always displays on the far right. When a waveform is frozen, the message [LABEL] FROZEN displays on the far left, along with the time of activation.

Battery-Backed RAM Status

Whenever you turn off a 120 Series Monitor, a battery provides power to the RAM (random access memory) that stores information such as time, date, default settings, etc.

Figure 3-10. Low Battery Icon

The icon shown above will appear in the upper right-hand section of the monitor under the following circumstances.

Table 3-10. Battery-Backed RAM Status

Icon Appearance	Reason	Solution
Icon appears and then disappears after power cycle.	Data corruption. Your monitor has reverted to factory settings.	Access setup screens and configure last-used settings.
Icon appears after multiple power cycles.	Battery requires service.	Call GE Service to report.

Softkeys

A softkey is an area on the screen that can be selected with the Trim Knob control. When the softkey is activated by pressing the Trim Knob control, it may cycle through available settings or it may display a setup screen.

Mode Title Softkeys

Most of the mode titles in the display are also softkeys which give access to corresponding setup screens: US, US2, FECG, NBP, MECG, PULSE, $FSPO_2$ and $MSPO_2$.

Waveform Softkeys

The waveform title is a softkey used to select the waveform for display or to disable the area, The ECG scale and MECG lead labels are softkeys used to configure the waveform currently displayed.

Dedicated Softkey Area

Softkeys are located at the bottom of each screen, as shown in Figure 3-11 and Figure 3-12. Although there are many possible softkeys which may appear in this area, a maximum of five are shown at a time.

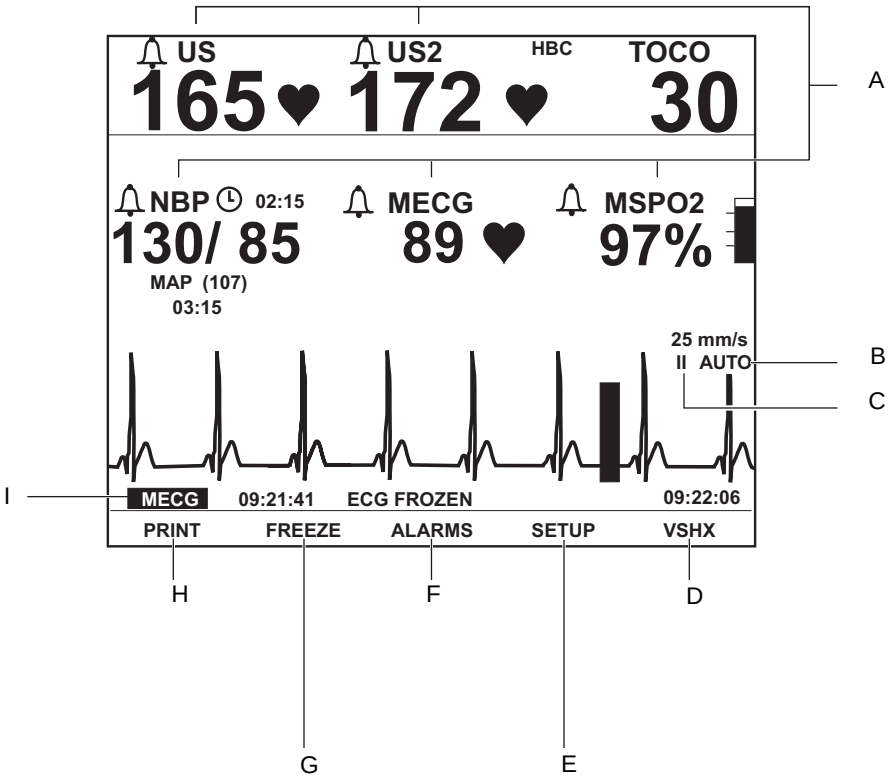


Figure 3-11. Display Summary

Table 3-11. Display Summary		
	Name	Description
A	Mode Title Softkeys	Selects US, US2, FECG, NBP, MHR/P, or SpO_2 Setup screens.
B	ECG Scale Softkey	Selects 0.25X, 0.5X, 1X, 2X, 4X, or AUTO.
C	MECG Lead Select Softkey	Selects Lead I, II, or III.
D	VSHX Softkey	Displays maternal Vital Signs History screen.
E	SETUP Softkey	Displays General Setup screen
F	ALARMS Softkey	Displays Master Alarm Setup screen.
G	FREEZE Softkey	Freezes waveform for analysis; unfreezes waveform to return to real-time display.
H	PRINT Softkey	Prints six-second snapshot of frozen waveform, real-time waveform, or maternal vital signs history.
I	Waveform Softkey	Selects FECG, MECG, $FSpO_2$, $MSpO_2$, or OFF.

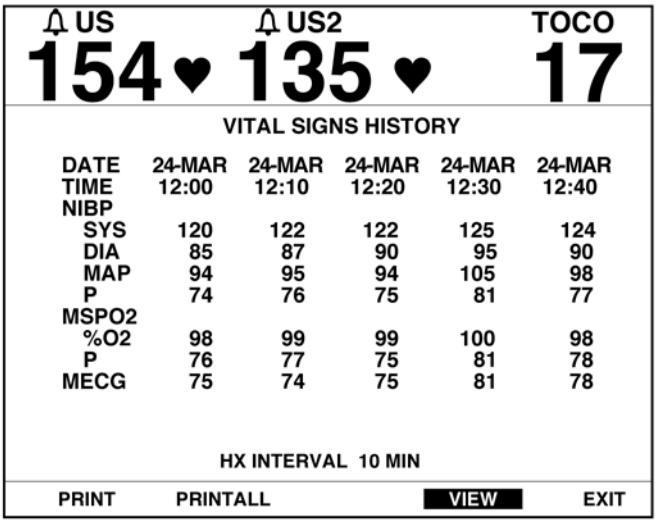


Figure 3-12. Maternal Vital Signs History Screen Softkeys

Table 3-12. Maternal Vital Signs History Screen Softkeys

	Name	Description
A	PRINT Softkey	Prints one page (screen) of the table.
B	PRINTALL Softkey	Prints all pages (screens).
C	VIEW Softkey	Scrolls through the data: ■ Left for recent data ■ Right for oldest data
D	EXIT Softkey	Returns to the previous screen.

Rear Panel Description

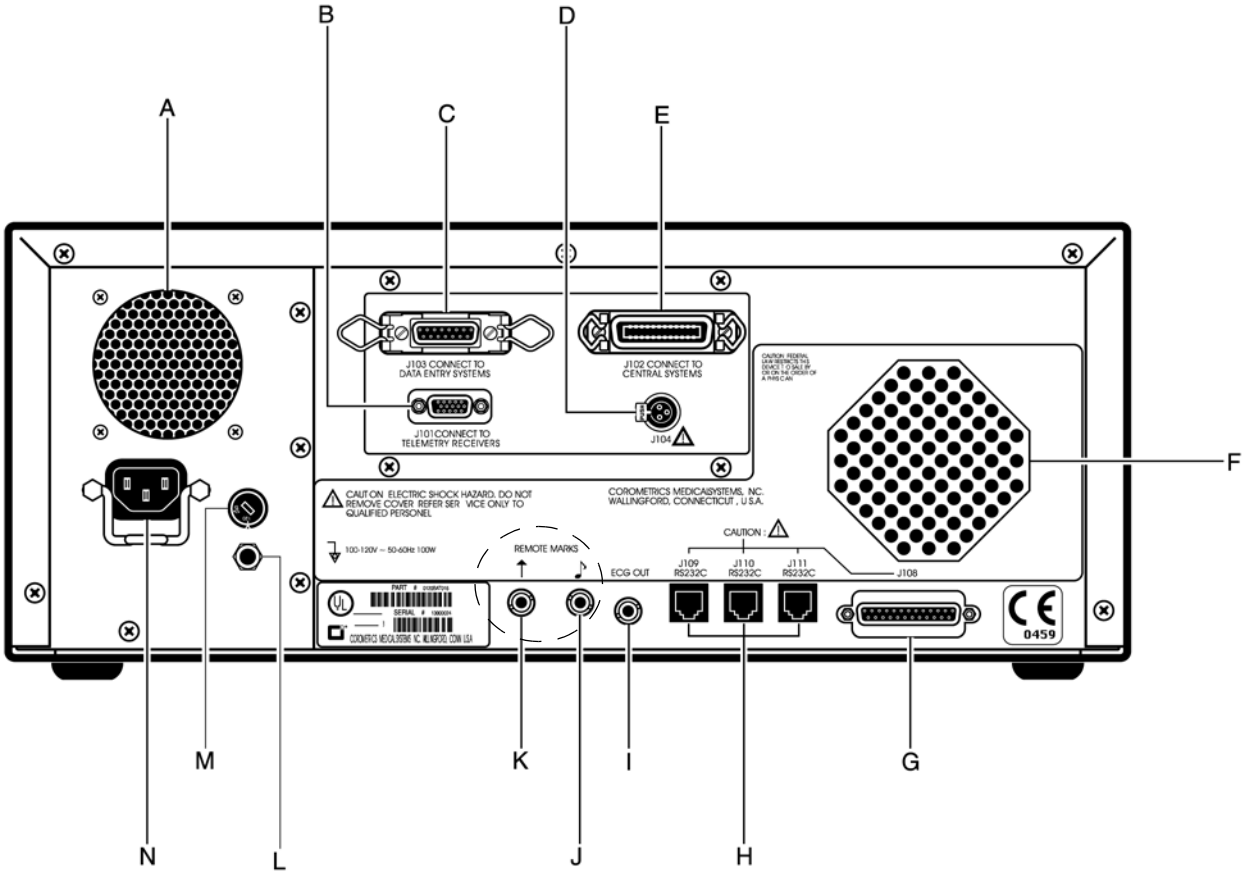


Figure 3-13. 120 Series Rear Panel Connectors (Standard and Optional)

IMPORTANT—The fetal acoustic stimulator connector (J) and the remote event marker (K) connector are identical in size. To ensure data accuracy, be sure to plug sensors into the correct connectors.

Table 3-13. 120 Series Rear Panel (Standard and Optional Features)		
	Name	Description
A	Vent	Provides ventilation for the monitor's internal circuitry.
B	J101 Telemetry Connector	Connector for Corometrics telemetry system interface. (Installed as part of an optional communications package.)
C	J103 Data Entry Connector	Connector for data entry system interface. (Installed as part of an optional communications package.)
D	J104 Nurse Call Connector	Connector for standard Nurse Call System interface. The connector's maximum output is 50 Vdc at 100 mA; the maximum on resistance is 0.5 Ω. (Installed as part of an optional communications package.)
E	J102 Central Systems Connector	Connector for analog central station system interface. (Installed as part of an optional communications package.)
F	Speaker	The rear panel speaker emits an audible tone for heart rates, $MSpO_2$ pulse with $\%O_2$-dependent pitch, and alarms. It also provides the sound for the song player feature.
G	J108 Corolan Connector	This 25-pin connector is used for interfacing to optional Corometrics equipment. Contact your Service Representative for more information.
H	J109, J110, and J111 RS-232C Communications Connectors	Three serial RJ-11 connectors are provided for interfacing to peripheral equipment. Contact your Service Representative for more information.
I	ECG Out Connector	External recorder receptacle for MECG signals. The standard output level is 1 V/mV.
J	Fetal Acoustic Stimulator Connector	Receptacle for Corometrics Model 146 Fetal Acoustic Stimulator (FAST). A music symbol prints on the strip chart paper each time the Model 146 is used: ♪
K	Remote Event Marker Connector	Receptacle for the Corometrics Remote Event Marker. When activated, one of the following marks prints on the strip chart paper: ■ The event marker is commonly used to record an "event": ↑ ■ The fetal movement marker (default setting) is commonly used as an indication that the mother has perceived fetal movement: FM↑

Table 3-13. 120 Series Rear Panel (Standard and Optional Features)		
	Name	Description
L	Equipotential Lug	A binding post terminal is directly connected to the chassis for use as an equipotentiality connection.
M	AC Voltage Selection Switch	This switch is intended for qualified service personnel to select a voltage range for the AC input: ■ 120: Accepts an AC input in the range of 100–120 VAC. ■ 240: Accepts an AC input in the range of 220–240 VAC
N	Power Entry Module	AC line power cord receptacle. Refer to the rear panel markings to verify line voltage and line frequency requirements.

NOTE: Although the J104 Nurse Call connector is physically present on the optional communications package, this connector is only supported as part of the Spectra Alerts option.

CAUTION

NON-DESTRUCTIVE VOLTAGE—The maximum non-destructive voltage that may be applied to the rear panel connectors is 0 volts. Do not attempt to connect cables to these connectors without contacting your Biomedical Engineering Department or *Information Technologies* Service Representative. This is to ensure the connectors comply with leakage-current requirements of one of the following applicable standards: Underwriters Laboratories UL-2601.1, Canadian Standards Associations CSA 22.2 No. 125, or International Electrotechnical Commission EN60601.1.

Communication Option

The communication option is an additional circuit board that can be installed in the 120 Series Monitor. Refer to “Chapter 12, Upgrading a 120 Series Monitor” , for upgrade information. The following four connectors are part of the optional communications package: J101, J102, J103, and J104.

J101 Connector

This high-density 15-pin connector is intended for interfacing to the receiver of a Corometrics 340 Series Telemetry System.

J102 Connector

This Centronics-type connector is used for interfacing to a central station system such as a Corometrics Spectra 400 Surveillance and Alert System. (This connector is often referred to as the Analog Interface Connector.)

J103 Connector

This 15-pin connector is used for attaching to an optional data entry system.

J104 Connector

This connector attaches to a standard Nurse Call System. The connector’s maximum output is 50 Vdc at 100 mA; the maximum on resistance is 0.5 Ω. When connected to a Nurse Call System, the monitor will activate the system each time a Spectra Alert is issued. This interface simulates pressing the button on a bedside Nurse Call System allowing nurses to respond to patient needs quickly and efficiently.

NOTE: Although the J104 Nurse Call connector is physically present on the optional communications package, this connector is only supported as part of the Spectra Alerts option.

Corolan Option

J108 is installed as part of a Corolan Option. Refer to “Chapter 12, Upgrading a 120 Series Monitor” for upgrade information.

Chapter 4

Theory of Operation

This section of the manual contains the electronic theory of operation for the 120 Series Monitor. For parts information, refer to "Chapter 14, Replacement Parts".

This chapter contains the following information:

Main Motherboard 4-2
DSP Board 4-24
NBP Board 4-35
Communications Board 4-39
System Power Supply. 4-44
Display Board. 4-45
Dual Ultrasound Board. 4-46
UA/FECG Board 4-52
MECG Board 4-61
Oximeter Carrier Board 4-70
MSpO2 Board 4-71
Isolated Power Supply Board. 4-76
Recorder Board 4-82

Main Motherboard

NOTE: Main Motherboard 2000608-003 (with software version 2.0) replaces earlier version 11619 Boards. If you update an older monitor (11619 Main Board and 3-inch x 3.75-inch display) with a new Main board, which is factory-set for the new larger display (3.5-inch x 4.5-inch display), the Main screen will have space below the bottom row of softkeys. Use the Flasher Software Utility Kit, to re-configure the monitor software to operate with the installed smaller display. Refer to "Display Upgrade" on page 12-40 and "Upgrading to a 3.5" x 4.5" Display" on page 7-11 for more information.

Functional Overview

The Main Motherboard makes up the central processing unit of the 120 Monitor. The Main Motherboard accepts simultaneously processed parameters directly from four separate modules. A Model 126 Monitor has the DSP Board as its only input module. Heart rate data, uterine activity data, mode information, and FMD data flow from the DSP Board to the Main Motherboard via shared memory. Maternal and fetal pulse oximetry make up the second and third modules. Information from these devices is passed to the Main Motherboard via internal RS-232C ports. Maternal blood pressure makes up the fourth module which also passes data via an internal RS-232C port. Figure 4-1 shows the data flow.

Switch/Status Input Data Flow Diagram

The Main Motherboard also processes information coming in from buttons and sensors. Information from the front panel switches comes from the DSP Board (passed through the main microprocessor). Status information comes from the Recorder Board and the Communications Board interface. Figure 4-2 provides a summary.

External/Internal Communication Data Flow

The Main Motherboard handles all internal and external data communications. Four external communication interfaces are present. For the Corolan interface, monitor data flows predominantly from monitor to master. Three external RS-232C communication interfaces are set up predominantly to receive data from external parameter monitors such as fetal pulse oximeters, maternal pulse oximeters, and maternal blood pressure monitors. Internal communications consists of three channels of RS-232C for NBP, $MSpO_2$, and $FSpO_2$. Figure 4-3 provides a summary of the communication data flow.

Audio Control Flow

Another function of the Main Motherboard is to control the audio from various sources. Pure audio (non-processor generated) information comes from the Ultrasound Board (US and US2) only. The remaining sources of audio are generated by the processor through the use of timers and the host processor. Timer sources of audio are initiated by the FECG, NBP, $MSpO_2$, and DSP internal modules. Audio

from the host processor is summed into the main audio and is not controlled by the main processor. Figure 4-4 provides a summary of the audio control flow.

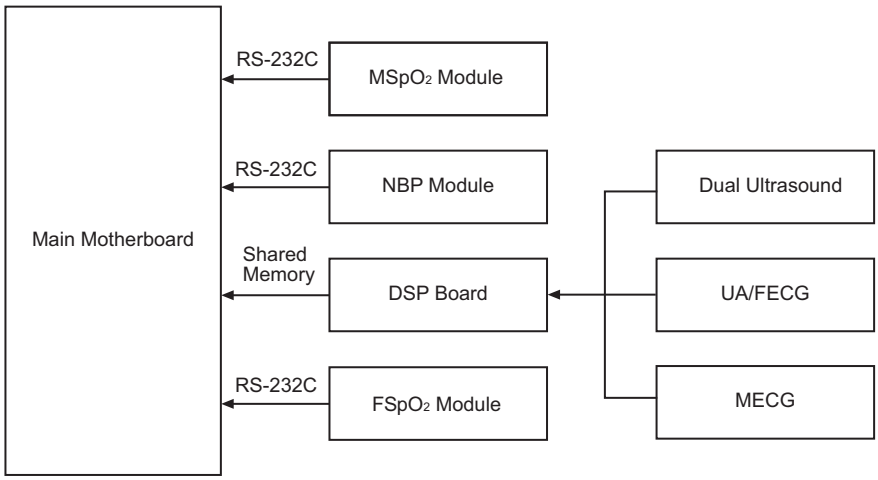


Figure 4-1. Main Motherboard Input Parameter Data Flow

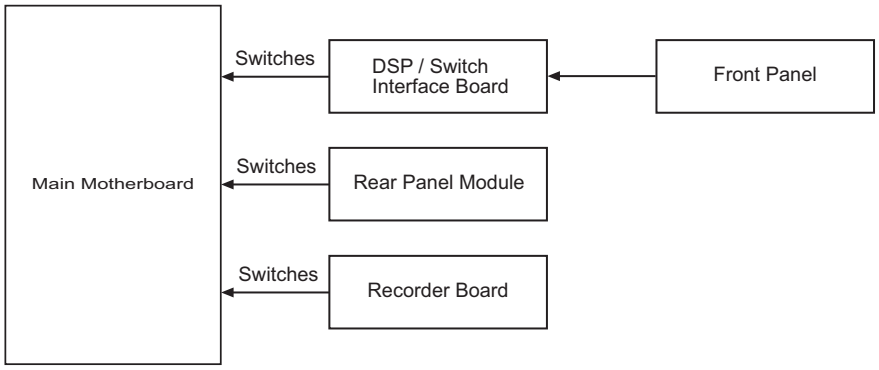


Figure 4-2. Main Motherboard Switch Input Data Flow

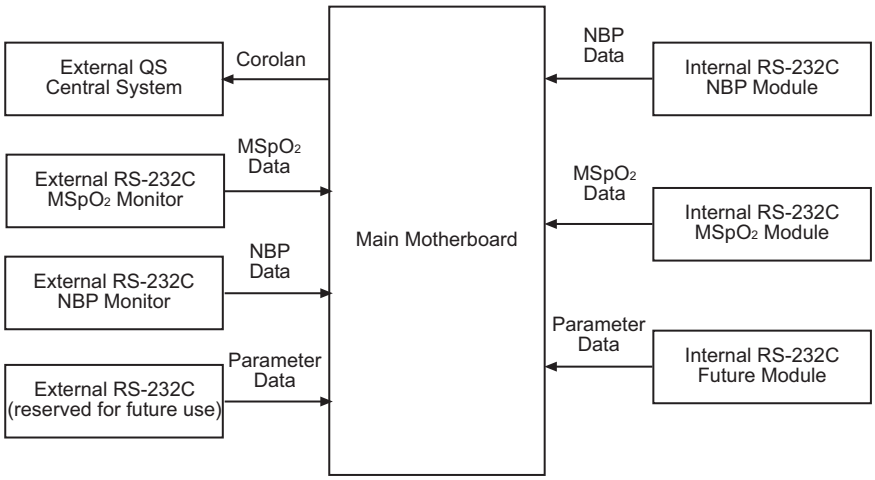


Figure 4-3. Main Motherboard Communications Data Flow

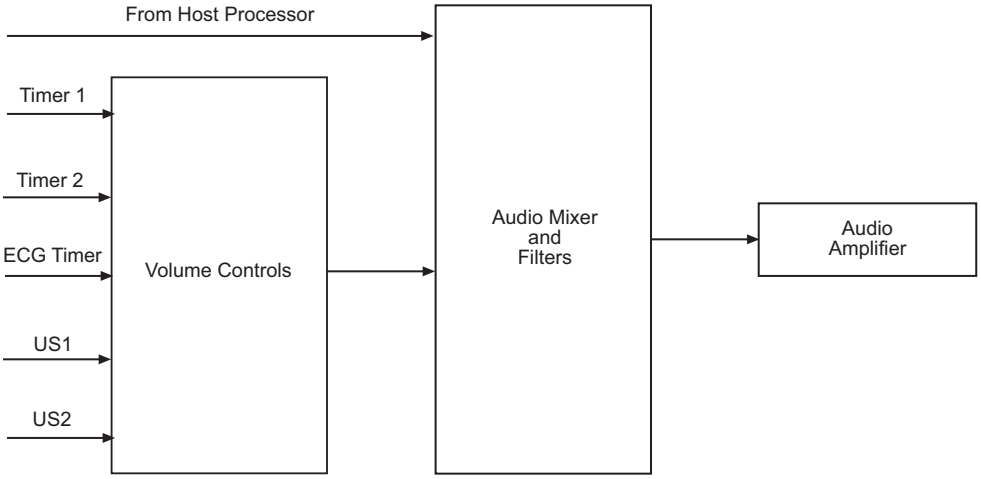


Figure 4-4. Main Motherboard Audio Control Flow

Table 4-1. Main Power Connector		
Pin Number	Signal Name	Signal Description
1	AGND	Analog Ground
2	GND	Digital Ground
3	GND	Digital Ground
4	GND	Digital Ground
5	+5V	+5V Logic Supply
6	+5V	+5V Logic Supply
7	+5V	+5V Logic Supply
8	GNDAUD	Audio Ground for +12 V
9	GNDBP	NBP and Isolated Supply Ground
10	+15BP	Supply for NBP
11	+12AUD	Supply for Audio
12	+12EL	Supply for EL panel
13	GNDEL	Ground for EL panel
14	+20I	20 V for Isolated Power Supply
15	GNDI	Ground for Isolated Power Supplies
16	+15US	+15 V for Ultrasound
17	–15V	–15 V for Ultrasound
18	72KHZ	Power Supply Sync Frequency from US Board

.

Table 4-2. RS-232 Connectors J11 and J13		
Pin Number	Signal Name	Signal Description
1	RTS	Request to Send Output from Monitor
2	RXD	Receive Data Input to Monitor
3	GND	Signal Ground
4	GND	Frame Ground
5	TXD	Transmit Data Output from Monitor
6	CTS	Clear to Send Input to Monitor

Table 4-3. RS-232 Connector J12		
Pin Number	Signal Name	Signal Description
1	RTS	Always Inactive
2	RXD	Receive Data Input to Monitor
3	GND	Signal Ground
4	GND	Frame Ground
5	TXD	Transmit Data Output from Monitor
6	No connection	—

Table 4-4. Corolan Connector J2		
Pin Number	Signal Name	Signal Description
1	No connection	—
2	GND	Ground
3	ADR0	Junction Box Address Line Input
4	ADR1	Junction Box Address Line Input
5	ADR2	Junction Box Address Line Input
6	ADR3	Junction Box Address Line Input
7	ADR4	Junction Box Address Line Input
8	ADR5	Junction Box Address Line Input
9	LED	Junction Box LED Control Line
10	No connection	—
11	No connection	—
12	No connection	—
13	SIGNAL GND	Signal Ground
14	No connection	—
15	No connection	—
16	No connection	—
17	No connection	—
18	No connection	—
19	CENTER COAX	Corolan Center Coax
20	SHIELD COAX	Corolan Shield Coax
21	No connection	—
22	No connection	—
23	No connection	—
24	No connection	—
25	No connection	—

Table 4-5. DSP Board Connector J7			
Pin Number	Signal Name	Signal Type (Relative To Main Motherboard)	Signal Description
1	IRQ7/	Input	Interrupt Line from DSP Board Shared RAM
2	SHEM/	Output	DSP Shared Memory Chip Select Line
3	No Connection	—	—
4	RESA02	Output	Reset Line for SpO_2 Module
5	RESDSP/	Output	Processor Controlled Reset Line
6	72kHz	Input	72 kHz from Front End to Sync Power Supplies
7	+15v	Output	+15 Volt Analog Supply
8	–15V	Output	–15 Volt Analog Supply
9	AGND	Output	Analog Ground
10	AGND	Output	Analog Ground
11	–15v	Output	–15 Volt Analog Supply
12	AGND	Output	Analog Ground
13	US2AUDIO	Input	Ultrasound2 Audio
14	GND	Output	Digital Ground
15	TMECG	Output	Telemetry MECG
16	TELMAUDIO	Input	Telemetry Audio
17	IRQ7/(alt)	Input	Alternate Interrupt from DSP Board (Jumper Selectable On to Processor IRQ7/ Line)
18	D0B	I/O	Buffered Data Line
19	D2B	I/O	Buffered Data Line
20	D4B	I/O	Buffered Data Line
21	D6B	I/O	Buffered data line
22	D8B	I/O	Buffered data line
23	D10B	I/O	Buffered data line
24	+5V	Output	+5 Volt Logic Supply
25	D12B	I/O	Buffered Data Line
26	D14B	I/O	Buffered Data Line
27	A1B	Output	Buffered Address Line
28	A3B	Output	Buffered Address Line

Table 4-5. DSP Board Connector J7 (Continued)			
Pin Number	Signal Name	Signal Type (Relative To Main Motherboard)	Signal Description
29	A5B	Output	Buffered Address Line
30	A7B	Output	Buffered Address Line
31	GND	Output	+5 Volt Power Ground Return
32	A9B	Output	Buffered Address Line
33	A11B	Output	Buffered Address Line
34	A13B	Output	Buffered Address Line
35	A15B	Output	Buffered Address Line
36	SP2B/	Output	Spare Chip Select Line
37	SP4B/	Output	Spare Chip Select Line
38	+5V	Output	+5 Volt Logic Supply
39	UDSB/	Output	Buffered Upper Data Strobe
40	+5V	Output	+5 Volt Logic Supply
41	GNDI	Output	20 V Ground
42	GNDI	Output	20 V Ground
43	IRQ6/	Input	Processor Interrupt Line
44	+20I	Output	+20 Volt Supply
45	+20I	Output	+20 Volt Supply
46	GND	Output	Digital Ground
47	GND	Output	Digital Ground
48	GND	Output	Digital Ground
49	GNDEL	Output	Ground Return
50	GNDEL	Output	Digital Ground
51	RXDC	Input	Main Bd. RXD Line for MSpO$_2$ Module
52	TXDB	Output	Main Bd. TXD Line for FSpO$_2$ Module
53	TXDC	Output	Main Bd TXD Line for MSpO$_2$ Module
54	RTSC	Output	Main Bd. RTS Line for MSpO$_2$ Module
55	RXDB	Input	Main Bd. RXD Line for FSpO$_2$ Module
56	+15us	Output	+15 Volts for Ultrasound
57	AGND	Output	Analog Ground
58	+15v	Output	+15 Volts Analog Supply

Table 4-5. DSP Board Connector J7 (Continued)			
Pin Number	Signal Name	Signal Type (Relative To Main Motherboard)	Signal Description
59	FECG 80db	Input	FECG Analog for Rear Panel Output
60	AGND	Output	Analog Ground
61	US1audio	Input	Ultrasound Channel One Audio
62	MECG 60db	Input	MECG Analog for Rear Panel
63	PACER/	Input	Pacemaker Detect Line
64	TECG	Output	Telemetry ECG
65	TTOCO	Output	TOCO-telemetry
66	FM	Output	Fetal Movement
67	GND	Output	Digital Ground
68	D1B	I/O	Buffered Data Line
69	D3B	I/O	Buffered Data Line
70	D5B	I/O	Buffered Data Line
71	D7B	I/O	Buffered Data Line
72	D9B	I/O	Buffered Data Line
73	D11B	I/O	Buffered Data Line
74	+5V	Output	+5 Volt Logic Supply
75	D13B	I/O	Buffered Data Line
76	D15B	I/O	Buffered Data Line
77	A2B	Output	Buffered Address Line
78	A4B	Output	Buffered Address Line
79	A6B	Output	Buffered Address Line
80	A8B	Output	Buffered Address Line
81	GND	Output	Digital Ground
82	A10B	Output	Buffered Address Line
83	A12B	Output	Buffered Address Line
84	A14B	Output	Buffered Address Line
85	A16B	Output	Buffered Address Line
86	SP1B/	Output	Spare Chip Select Line
87	SP3B/	Output	Spare Chip Select Line
88	+5V	Output	Volt Logic Supply

Table 4-5. DSP Board Connector J7 (Continued)			
Pin Number	Signal Name	Signal Type (Relative To Main Motherboard)	Signal Description
89	LDSB/	Output	Processor Lower Data Strobe
90	R/WB/	Output	Processor Read/Write Line
91	No Connection	—	—
92	CKD	Output	Processor Clock Line 16/20 MHz
93	+5v	Output	+5 Volts Logic Power
94	+20I	Output	+20 Volts
95	RESFP/	Output	Front Panel Reset Line
96	GNDI	Output	+20 V Ground
97	+12EL	Output	+12 EL Panel Supply
98	+12EL	Output	+12 EL Panel Supply
99	GNDEL	Output	EL Panel Ground Return
100	GNDEL	Output	EL Panel Ground Return

Table 4-6. NBP Board Connector J4			
Pin Number	Signal Name	Signal type	Signal Description
1	GND	Output	+5 V Power Ground Return
2	D0B	I/O	Buffered Data Line
3	D2B	I/O	Buffered Data Line
4	D4B	I/O	Buffered Data Line
5	D6B	I/O	Buffered Data Line
6	D8B	I/O	Buffered Data Line
7	D10B	I/O	Buffered Data Line
8	+5V	Output	Volt Logic Supply
9	D12B	I/O	Buffered Data Line
10	D14B	I/O	Buffered Data Line
11	A1B	Output	Buffered Address Line
12	A3B	Output	Buffered Address Line
13	A5B	Output	Buffered Address Line
14	A7B	Output	Buffered Address Line
15	GND	Output	+5 Volt Power Ground Return
16	A9B	Output	Buffered Address Line
17	A11B	Output	Buffered Address Line
18	A13B	Output	Buffered Address Line
19	A15B	Output	Buffered Address Line
20	SP2B/	Output	Spare Chip Select Line
21	SP4B/	Output	Spare Chip Select Line
22	+5V	Output	+5 Volt Logic Supply
23	UDSB/	Output	Buffered Upper Data Strobe
24	+15BP	Output	+15 Volt Supply for NBP Module
25	+12VEL	Output	+12 Volt Analog Supply
26	GNDBP	Output	NBP Module Ground
27	GNDBP	Output	NBP Module Ground
28	IACK6/	Output	Processor Interrupt Acknowledge Line
29	IRQ6/	Input	Processor Interrupt Line
30	GND	Output	Digital Ground

Table 4-6. NBP Board Connector J4 (Continued)			
Pin Number	Signal Name	Signal type	Signal Description
31	SPARESTAT0	Input	NBP Board Present Line—active Low
32	SPARESTAT1	Input	Spare Present Line—active Low NOTE: These lines also go to the spare slot.
33	GNDBP	Output	NBP Module Ground
34	GNDBP	Output	NBP Module Ground
35	+15BP	Output	+15 Volt Supply for NBP Module
36	+15V	Output	+15 Volt Analog Supply
37	AGND	Output	Analog Ground
38	GNDI	Output	+20 V Ground
39	GNDI	Output	+20 V Ground
40	RES1/	Output	System Power-On Reset Line
41	GND	Output	Digital Ground
42	D1B	I/O	Buffered Data Line
43	D3B	I/O	Buffered Data Line
44	D5B	I/O	Buffered Data Line
45	D7B	I/O	Buffered Data Line
46	D9B	I/O	Buffered Data Line
47	D11B	I/O	Buffered Data Line
48	+5V	Output	+5 Volt Logic Supply
49	D13B	I/O	Buffered Data Line
50	D15B	I/O	Buffered Data Line
51	A2B	Output	Buffered Address Line
52	A4B	Output	Buffered Address Line
53	A6B	Output	Buffered Address Line
54	A8B	Output	Buffered Address Line
55	GND	Output	Digital Ground
56	A10B	Output	Buffered Address Line
57	A12B	Output	Buffered Address Line
58	A14B	Output	Buffered Address Line
59	A16B	Output	Buffered Address Line
60	SP1B/	Output	Spare Chip Select Line

Table 4-6. NBP Board Connector J4 (Continued)			
Pin Number	Signal Name	Signal type	Signal Description
61	SP3B/	Output	Spare Chip Select Line
62	+5V	Output	Volt Logic Supply
63	LDSB/	Output	Processor Lower Data Strobe
64	R/WB/	Output	Processor Read/Write Line
65	+15BP	Output	+15 Volt Supply for NBP Module
66	DTACK/	I/O	Processor DTACK Transfer Line
67	RXDD	Input	Main Motherboard RXD Line from NBP Module
68	TXDD	Output	Main Motherboard TXD Line to NBP Module
69	CKE	Output	20 MHz Clock
70	GND	Output	Digital Ground
71	No Connection	—	—
72	72kHz	Output	72 kHz from US Board
73	RTSD	Output	Main Motherboard RTS Line to NBP Module
74	CTSD	Input	Main Motherboard CTS Line from NBP Module
75	GND	Output	Digital Ground
76	–15V	Output	Volt Analog Supply
77	AGND	Output	–15 Volt Analog Supply
78	+20I	Output	+20 Volts for Isolated Power Supply
79	+20I	Output	+20 Volts for Isolated Power Supply
80	RESA/	Output	Processor Controlled Reset

Table 4-7. Communications Board Connector J5			
Pin Number	Signal Name	Signal Type	Signal Description
1	GND	Output	+5 V Power Ground Return
2	D0B	I/O	Buffered Data Line
3	D2B	I/O	Buffered Data Line
4	D4B	I/O	Buffered Data Line
5	D6B	I/O	Buffered Data Line
6	D8B	I/O	Buffered Data Line
7	D10B	I/O	Buffered Data Line
8	+5V	Output	+5 Volt Logic Supply
9	D12B	I/O	Buffered Data Line
10	D14B	I/O	Buffered Data Line
11	A1B	Output	Buffered Address Line
12	A3B	Output	Buffered Address Line
13	A5B	Output	Buffered Address Line
14	A7B	Output	Buffered Address Line
15	GND	Output	+5 V Power Ground Return
16	A9B	Output	Buffered Address Line
17	A11B	Output	Buffered Address Line
18	A13B	Output	Buffered Address Line
19	A15B	Output	Buffered Address Line
20	SP2B/	Output	Spare Chip Select Line
21	SP4B/	Output	Spare Chip Select Line
22	+5V	Output	+5 Volt Logic Supply
23	UDSB/	Output	Buffered Upper Data Strobe
24	No Connection	—	—
25	+12VEL	Output	+12 Volt Analog Supply
26	COMMSTAT0/	Input	J102 Communications Board Present Line—Active Low
27	COMMSTAT1/	Input	Board Present Line—Active Low
28	IACK6/	Output	Processor Interrupt Acknowledge Line
29	IRQ6/	Input	Processor Interrupt Input Line

Table 4-7. Communications Board Connector J5 (Continued)			
Pin Number	Signal Name	Signal Type	Signal Description
30	GND	Output	Digital Ground
31	SPRXD	Input	Processor Serial Input
32	TMECG	Input	Telemetry MECG
33	TELMAUDIO	Input	Telemetry Audio
34	US1AUDIO	Output	Ultrasound Unbuffered Audio
35	US2AUDIO	Output	Ultrasound 2 Unbuffered Audio
36	+15V	Output	+15 Volt Analog Supply
37	AGND	Output	Analog Ground
38	FM	Output	Fetal Movement (not used)
39	No Connection	—	—
40	RES1/	Output	System Power-On Reset Line
41	GND	Output	Digital Ground
42	D1B	I/O	Buffered Data Line
43	D3B	I/O	Buffered Data Line
44	D5B	I/O	Buffered Data Line
45	D7B	I/O	Buffered Data Line
46	D9B	I/O	Buffered Data Line
47	D11B	I/O	Buffered Data Line
48	+5V	Output	+5 Volt Logic Supply
49	D13B	I/O	Buffered Data Line
50	D15B	I/O	Buffered Data Line
51	A2B	Output	Buffered Address Line
52	A4B	Output	Buffered Address Line
53	A6B	Output	Buffered Address Line
54	A8B	Output	Buffered Address Line
55	GND	Output	Digital Ground
56	A10B	Output	Buffered Address Line
57	A12B	Output	Buffered Address Line
58	A14B	Output	Buffered Address Line
59	A16B	Output	Buffered Address Line
60	SP1B/	Output	Spare Chip Select Line

Table 4-7. Communications Board Connector J5 (Continued)			
Pin Number	Signal Name	Signal Type	Signal Description
61	SP3B/	Output	Spare Chip Select Line
62	+5V	Output	+5 Volt Logic Supply
63	LDSB/	Output	Processor Lower Data Strobe
64	R/WB/	Output	Processor Read/Write Line
65	AGND	Output	Analog Ground
66	DTACK/	I/O	Processor DTACK Transfer Line
67	No Connection	—	—
68	No Connection	—	—
69	CKC	Output	20 MHz Clock
70	GND	Output	Digital Ground
71	No Connection	—	—
72	No Connection	—	—
73	No Connection	—	—
74	No Connection	—	—
75	GND	Output	Digital Ground
76	–15V	Output	–15 Volt Analog Supply
77	AGND	Output	Analog Supply
78	TECG	Input	Telemetry ECG
79	TOCO	Input	TOCO-Telemetry
80	RESB/	Output	Processor Controlled Reset Line RESB/

Table 4-8. Recorder Board Connector J9			
PIN NUMBER	Signal Name	Signal Type	Signal Description
1	No Connection	—	—
2	STB4/	Output	Strobe Line for 4th Set of 256 Dots (1024 element)
3	PLOW/	Input	Paper Low Line
4	STB3/	Output	Strobe Line for 3rd Set of 256 Dots (1024 element)
5	POUT/	Input	Paper Out Line
6	STB2/	Output	Strobe Line for 2nd Set of 256 Dots (1024 element)
7	DOOR	Input	Door Closed Line (Not Used)
8	STB1/	Output	Strobe Line for 1st Set of 256 Dots (1024 element)
9	GND	Output	Ground
10	BEO	Output	Printhead Enable Line
11	RECLK	Output	Recorder Serial Clock (2.5 MHz)
12	LD/	Output	Recorder Load Line
13	GND	Output	Ground
14	RES/	Output	System Reset Line
15	RECDATA	Output	Recorder Data Line
16	HDSHUT/	Output	Recorder Head Power Supply Shutdown Line
17	P2	Output	Stepper Motor Phase 2
18	P4	Output	Stepper Motor Phase 4
19	P1	Output	Stepper Motor Phase 1
20	P3	Output	Stepper Motor Phase 3

Table 4-9. Remote Mark Jack—PH2	
Pin Number	Description
Inner Conductor	Remote Mark Input Line
Outer Ring	Remote Mark Ground

Table 4-10. Fetal Acoustic Stimulator (FAST) Jack—PH3	
Pin Number	Description
Inner Conductor	FAST Mark Input Line
Outer Ring	Mark Ground

Table 4-11. FECG/MECG Jack—PH1	
Pin Number	Description
Tip Conductor 1	FECG 80 dB Output Line
Center Conductor 2	MECG 60 dB Output Line
Outer Ring	Ground

Table 4-12. Legplate Connector—J1	
Pin Number	Description
1	LA
2	ECG Common (RL and RA)
3	ECG Common

Control Block

The control block contains the basic processing engine (68302), system RAM, system ROM, address decoder, power-on reset module, oscillator, and control/setup section. The 68302 device (U33) contains a 68000 core processor, chip select logic (CS0/–CS3/), two timers, DTACK generation/wait state logic, a general purpose DMA controller, watchdog timer, interrupt controller, three USARTs with six dedicated DMA channels for transmit/receive, three-wire serial link, and 1152 bytes of dual port RAM. The clock for the 68302 is derived from a 20 MHz crystal (X3) connected to the processor. The processor system clock is output from the processor via the CLKO pin. This clock is then buffered and sent to the Options Interface, DSP Interface, and local 16V8H control PAL (U34). The power-on reset function is accomplished through MAX691A supervisory chip (U24). This chip performs four functions. First, at power-up, a 200 ms reset pulse is generated. The second function is a watchdog timer which must be written every 100 ms or faster, and up to 1.6 seconds after reset. The third function provides power supply monitoring, which resets the system if the supply falls below 4.65 V. The fourth function provides an early power fail detection status line (routed to PB11, pin 121) of U33). The comparator senses a power fail when the regulated +20 V falls below 18 V. This gives the processor 40 ms to shut down the monitor. The processor can also be reset by the Host Board through the HRES* line and AND gate U37. The serial output channel is used to write to the recorder printhead shift register. Each time a byte is sent from this port, eight clocks are generated on the RECLK line (pin 77 of U33), 2.5 MHz serial rate, along with the serial data RECDATA (pin 78 of U33). One of the two internal timers is used externally for the ECG audio (pin 113 of U33). For communications, one USART is used for the Corolan interface, and the other two are used for external RS-232C communication. The address decoder consists of a 7032 PLD (U20), which basically divides up the four programmable chip selects (CS0/–CS3/) from the processor into all of the board selects. The processor (U33) is programmed such that CS0/ is a 4 MB space with internally generated DTACK and zero wait states. This space is then divided further by the 7032 (U20) to form the system flash ROM, RAM, and SP2* (spare chip select which goes to the options interface) chip selects. CS1* is a 2 MB space with external DTACK expected. The 7032 forms the 68C94 QUART chip select and SP1* (spare select to options interface). CS2* is a 2 MB select with a six wait state internal DTACK. The 7032 generates the decodes for audio DACs, battery RAM, DSP shared memory, and SP4* (spare select to options interface) from CS2*. CS3* is a 2 MB select with a two wait state internal DTACK. The 7032 generates the control/dip switch, front panel, recorder, and SP3* (spare select to options interface) chip selects from CS3*. The 16V8 PAL (U34) converts the processor control lines to form upper and lower read/write lines. Corolan transmit control is also accomplished with this 16V8. The control/setup section consists of two 8-bit latches (U21, U22) for I/O control and a buffer (U3) for reading dip switches (SW1). The control latch allows control of the watchdog timer, battery RAM enable, audio enables, reset lines for peripherals, and Corolan control lines. The system memory consists of two 512k x 8 flash ROMS (U31, U32), two 128k x 8 static RAMs (U18, U19) upgradable to 512k x 8 RAMs, and one 8k x 8 battery RAM (U30).

Corolan Module

The Corolan section consists of the network transceiver section and the address detection circuitry. Network data flows through the common mode transformer (T2) to the isolation pulse transformer PE5156 (T1) to the transceiver/manchester encoder-decoder (U16). Serial data and clocks are then fed to the USART in U33.

The 7960 encoder/decoder operates in mode 0, thus inserting its own preamble and removing it at the receiver end. On the receiving end, the CS/ line becomes active along with the receive clock after the preamble is stripped off, thus enabling the USART. For transmission, a carrier avoidance scheme is accomplished through 16V8 PAL (U34) and 7960 ACD/ and RTS/ lines. The 7960 will transmit whenever the RTS/ line is pulled low. The advanced carrier detect line (ACD/), is gated along with an RTS enable from control latch U22 and processor USART RTS/ line to only turn on the 7960 RTS/ line when ACD/ is inactive (QUIET LINE). Both the transmit and the receive clocks are provided by the 7960. The address detection circuitry consists of a buffer (U17), series resistors (R30–R35) and capacitors (C120–C125) for static protection, and address checking logic in U29. The address checking is done by reversing the GND and pull-up voltages (through the TEST line), and reading back all 1s if lines are not broken. If any line is broken (pull-up single in-line package, RN1, pulled low for TEST and GND line pulled high), then a 0 will be detected. Normal reading of the address selects the pull-up single in-line package high and GND line low. Refer to Figure 4-5.

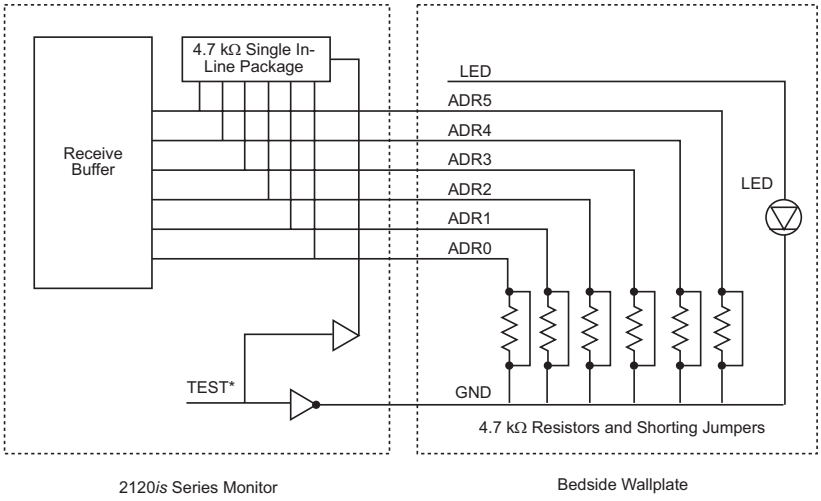


Figure 4-5. Corolan Address Checking

Options Interface

The options interface consists of a buffered processor address/control and data bus, three 80-pin connectors, and one 100-pin connector. All options connectors contain 16-bit address and data buses, along with four spare chip select lines. The Communications Board connector (J5) contains ultrasound audio lines and telemetry signals from the rear panel. The NBP 80-pin connector (J4) differs in that it has pins for the +20 V supply (+20I) and the NBP power supply (+15BP) and does not have the telemetry signals. The 100-pin connector (J7) for the DSP Board also has the telemetry signals, +20 V for the isolated power supply, as well as an additional +12 V supply for the EL display. The Communications Board holds the J102 analog output circuitry and connector, keyboard circuitry and connector, and telemetry input connector. The spare option slot is not used currently,

The DSP front panel interface section (goes through the options interface), consists of a 1k x 8 shared memory upgradable to 2k x 8 and a DSP Board connector. The shared memory arbitration logic (BUSY line) is not used. The interrupt logic in the shared memory is tied to the 68302 processor and is also read through the rear panel interface port (IRQ7/). The rest of the lines on the DSP connector route the ultrasound audio, FECG80dB, MECG60dB, and the telemetry lines to the options interface communications connector and rear panel jacks. RS-232C lines for the $MSpO_2$ and $FSpO_2$ modules are also present (connects to channel C and B of 68C94 QUART) on the DSP connector. The front panel interface section is just part of the general processor interface (data, address, and control).

Rear Panel Interface

This section consists of a buffer (U8) which receives the remote mark and FAST inputs, analog buffers (in U7) which output the FECG 80 dB and MECG 60 dB signals, and legplate signal circuitry. (Only early models have legplate connectors.) A 500 ms square wave is generated from the control latch (U22) and is wave shaped and attenuated to about 15 mV.

Audio Section

This section consists of a four channel volume control and bridge type power amplifier. Two of the volume controls (dual DAC U14), are preceded by an analog multiplexor (U28) which allows US or US2 audio on one channel and US2 or ECG timer audio on the other channel. The second set of volume controls are dedicated to two timers from the QUART chip (U2). All of the timers are pre-filtered (U15, U12) to eliminate the high frequency components from the audio. The outputs of the four volume controls are then summed together (U13) and fed to the TDA1519 stereo amplifier (U1). The TDA1519 is stereo amplifier connected in a bridge configuration in order to eliminate the large series coupling cap and non-standard power supply requirements.

Recorder Interface Section

The recorder interface section consists of 7032 interface PAL (U38), recorder clock and data buffers (U36), and clock divider 74HC4040 (U39). The interface PAL contains latches to create the four strobe lines, load line, and stepper motor four phases along with head protection circuitry which automatically shuts off all of the strobes and the HDSHUT* line (turns head power supply off). The protection works by enabling the external counter when a strobe line is turned on, and automatically disabling the strobes (and enable HDSHUT*) lines after a 6.1 ms timeout. A buffer is also present which allows the paper out (POUT*) and paper low (PLOW*) lines to be read. Logic for the QUART reset line, ORs (in U38) the system reset with the control latch reset to form a positive reset output to the QUART.

RS-232C Communications Section

This section provides the external and internal RS-232C functions. These ports (J109, J110, J111) are driven from the 68302 processor. The J110 port only supports TXD and RXD lines while J109 and J111 supports RTS and CTS as well. The QUART (U2) drives three internal RS-232 ports (NBP, $MSpO_2$, and $FSpO_2$) as well as one external port (SpO_2).

DSP Board

NOTE: Refer to "Chapter 14, Replacement Parts", to determine the correct DSP Board for your monitor.

Functional Overview

This board consists of two independently functioning modules: DSP and front panel interface.

The DSP section processes analog and digital data from the front ends and interfaces to the main processor. The ECG and ultrasound analog information is processed and heart rates are outputted to the Main Motherboard via a shared memory. Digital pressure information is received, processed, and also sent to the shared memory.

The front panel interface section provides the interface between the front panel switch board and the main processor as well as the EL display panel and the processor. The switch interface section consists mainly of buffers. The display section consists mainly of a shared memory and timing generator PAL.

DSP Section

Control Module

This section consists of the TMS30C52 DSP processor (U27), 32k x 16 system RAM (U10, U11), 128K x 16 flash ROM (U8, U9), and two address decoder PALs (U18 and U19). Decoder PAL U19 selects the RAM, flash ROM, and the front end control status locations BCS0*–BCS3*. RAM is decoded using DS* (data strobe); flash ROM is decoded using PS* (program strobe); and the remaining lines are decoded using IS* (I/O strobe). Pal U18 selects the I/O for the status/control section, A/D read and start convert signals, and pressure channel select and start convert signals. The program address space is 64k minus the bottom 8k which is used for program RAM. The flash ROM runs with one wait state. The second half of the flash ROM can be addressed by toggling D10 of the control port (tied to A16 of the flash ROM). All 32k x16 system RAM is accessed as zero wait state data memory. In addition, the lower 8k of the system memory is double mapped to the last 8k of the 64k program memory.

Watchdog Module

The watchdog module consists of processor supervisor chip max694 (U26). This chip provides a power-on reset function and a watchdog timer function.

The RESET line is pulled low for 50 ms for both a power-on and watchdog reset. The watchdog timer times out after a 1-second minimum.

Status/Control Module

This module consists of control latches (U5, U7) and a status buffer (U6). The control latch has bits which select the input multiplexor (MUX0–MUX3), control the high/low bytes coming from the A/D (BYTE), reset the front end (RESFR*), enable the front-end control interface (U1 CNTRLEN*), control flash ROM paging, and control the pressure channel interface (IUPCLR*). The status buffer reads in the interrupt line (INTL*) from the shared memory (on Main Motherboard), BUSY* line from the A/D and the pacemaker pulse (PACER*).

Front-End Control/Status Interface

This section consists of a transceiver (U20) and a buffer (U14). The transceiver allows 8 bit bi-directional data to be transferred to and from the front-end modules. Data is controlled by the buffered read (BRD*), write (BWR*), chip select lines (CS0*–CS3*), and address lines (BA0–BA1). Status information such as modes and control information for ultrasound, FECG, MECG, and UA are read through this port.

IUP Interface

The IUP interface section consists of two 8-bit serial-in parallel-out shift registers (U16, U17) and a start conversion line (CVRT*). The process is started by the 320C52 processor (U27) pulsing the CVRT* line which connects to a serial A/D in the pressure channel front end. Twelve data clocks are then issued from the A/D, clocking in the 12-bit result. The shift register clock for U16 and U17 is delayed through R12/C10 and U15 to provide the latch clock for U16 and U17. Data is then read by the processor through the IUP chip select line. As a second function, the clock signal is also used to clock serial mode and status information across the isolation barrier from the UA/FECG and MECG Boards. Information to and from the ECG Boards is transferred via the status/control module.

Analog Conversion Module

The analog conversion module consists of an input multiplexor (U21), a multiplexor buffer amplifier (U22), a 12-bit A/D chip (U23), and a data buffer (U24). The multiplexor takes in the two ultrasound envelope signals, FECG and MECG signals, fetal movement detection signals, fetal movement envelope signals, telemetry signals, ECG signals, TOCO signals, analog ground, and +10 V and –5 V reference signals for test and calibration. The +10 V reference is also used by the ultrasound module. Data out of the multiplexor is then buffered by one section of U22 and passed to the A/D chip U23. The 2.5 V reference in the A/D is buffered and amplified to +10 V and –5 V using two more sections of U22. A/D output data is read by the processor through a buffer (U24) one byte at a time. Byte selection is controlled by the BYTE line going to U23, pin 24.

Front Panel Interface Section Theory

EL Panel Interface

The interface consists of two major sections: shared memory and graphics generator.

The shared memory consists of a 8k x16 dual port RAM (U29) which has contention logic. The processor is given priority to read or write data into the RAM without waiting. In a contention situation, the graphics side of the memory could possibly receive wrong or changing data; however since data is changing anyway, this is not noticed. Also, contention occurs only when both address are the same, about once or twice a second in this case. Since the dual port RAM cannot give priority to either side if one side accesses before the other, the PAL accomplishes this by gating the processor side BUSY signal (normally holds off the processor) with the graphics side chip select such that the graphics chip select is turned off immediately.

The graphics section consists of the graphics generator PAL (U13), oscillator (OSC1), and output synchronization latch (U1). The graphics generator contains a divide-by-four pre-scaler, a horizontal counter chain, a vertical counter chain, decoding logic to control each counter operation, a 16-bit shift register, and control logic for pattern, inverse, and scan stop functions. The El panel size is 320 bits across by 256 lines down. The horizontal counter was set up to count to 335 (16 bits or one word of off time for horizontal) then reset to zero. The horizontal waveform is generated off the counter by decoding 320. The horizontal high time is then 20 words and off time one word. The output of the horizontal counter clocks the vertical counter chain. A decode of 262 is created to form the vertical pulse as well as clear the vertical counter. A count of 262 was used instead of 256 to meet the EL panel specification for frame rate (72 Hz maximum). After line 256, the EL panel does not display information until a vertical occurs. The load pulse for the shift register is created by decoding the least significant 4 bits of the horizontal counter and the video clock. The shared RAM graphics side chip select is created in the same fashion. Data for the shift register (from shared RAM) first is gated through the pattern logic before entering the shift register. The pattern logic simply forces each alternating bit to a 1/0 pattern. This creates an on/off pattern of lines down the screen. To further enhance the pattern, the output of the shift register data is inverted every other horizontal line. This creates an alternating pixel pattern in both horizontal and vertical directions. The output of the shift register also contains logic to invert data. The stop scan function allows the processor to update the screen (i.e. moving bar) without having the graphics scan the changing data. This function is accomplished by stopping the timing generator including the video clock. Stopping the scan for less than 10% of the frame rate (14 ms frame rate) can be accomplished without causing the video to degrade.

Front Panel Switch Interface

This section consists of simple buffers (U2, U3) for the incoming switch closures as well as static protection resistors (RN10, RN11) and capacitors.

An additional latch (U4) is used to control the recorder LED line as well as the video pattern, stop scan, and invert lines.

Table 4-13. Front End Connector J1

Pin Number	Signal Name	Signal Type (Relative to Main Motherboard	Signal Description
1	GND	Output	Digital Ground
2	BD6	I/O	Status/Control Bus Bit 6
3	BD7	I/O	Status/Control Bus Bit 7
4	CS0/	Output	Status/Control Bus Chip Select 0
5	CS1/	Output	Status/Control Bus Chip Select 1
6	CS2/	Output	Status /Control Bus Chip Select 2
7	CS3/	Output	Status/Control Bus Chip Select 3
8	+5V	Output	+5 V Logic Supply
9	BRD*	Output	Status/Control Bus Read Line
10	BA1	Output	Status/Control Bus Address Line Bit 1
11	RESDSP*	Output	DSP Board Reset Line
12	RESFR*	Output	Unused
13	144KHZ	Input	Ultrasound 144 kHz Output
14	72KHZ	Input	Ultrasound 72 kHz Output
15	GND	Output	Digital Ground
16	RESAO2	Output	$MSpO_2$ Module Reset Line From Main Motherboard
17	+5V	Output	+5 V Logic Supply
18	IUPCLK	Input	IUP Clock from IUP Front End
19	CVRT/	Output	IUP Start Conversion Line to IUP Front End
20	IUPDATA	Input	IUP Data Line from IUP Front End
21	No Connection	—	—
22	No Connection	—	—
23	–15V	Output	–15 V Supply
24	–15V	Output	–15 V Supply

Table 4-13. Front End Connector J1 (Continued)			
Pin Number	Signal Name	Signal Type (Relative to Main Motherboard	Signal Description
25	AGND	Output	Analog Ground
26	GNDUS	Output	Analog Ground
27	–15V	Output	–15 V Supply
28	AGND	Output	Analog Ground
29	US2AUDIO	Input	Ultrasound CH2 Audio
30	No Connection	—	—
31	FMENVL2	Input	Unused
32	FMD2	Input	Fetal Movement Detection CH2
33	FMD1	Input	Fetal Movement Detection CH1
34	FECG	Input	FECG Analog
35	FECG 80DB	Input	FECG 80 dB Analog
36	USTESTIN	Input	Test Input To A/D
37	US2 ENV	Input	Ultrasound Envelope CH2
38	FECGRAW	Input	FECG Raw Analog
39	US1 ENV	Input	Ultrasound Envelope CH1
40	AGND2	Output	Analog Ground
41	No Connection	—	Isolation Barrier
42	No Connection	—	Isolation Barrier
43	No Connection	—	Isolation Barrier
44	No Connection	—	Isolation Barrier
45	No Connection	—	Isolation Barrier
46	No Connection	—	Isolation Barrier
47	GNDI	Output	Ground Input for Isolated Power Supply
48	GNDI	Output	Ground Input for Isolated Power Supply
49	+20I	Output	+20 Volts Input For Isolated Power Supply
50	+20I	Output	+20 Volts Input For Isolated Power Supply
51	GND	Output	Digital Ground
52	BD0	I/O	Status/Control Bus Data Bit 0
53	BD1	I/O	Status/Control Bus Data Bit 1
54	BD2	I/O	Status/Control Bus Data Bit 2

Table 4-13. Front End Connector J1 (Continued)			
Pin Number	Signal Name	Signal Type (Relative to Main Motherboard	Signal Description
55	BD3	I/O	Status/Control Bus Data Bit 3
56	BD4	I/O	Status/Control Bus Data Bit 4
57	BD5	I/O	Status/Control Bus Data Bit 5
58	+5V	Output	+5 V Logic Supply
59	BWR*	Output	Status/Control Bus Write Line
60	BA0	Output	Status/Control Bus Address Line Bit 0
61	SARXD	Input	Main Motherboard RXD Line for $MSpO_2$ Module ($MSpO_2$ TXD)
62	TXDB	Input	Main Motherboard TXD Line for $FSpO_2$ Module
63	SATXD	Output	Main Motherboard TXD Line To $MSpO_2$ Module ($MSpO_2$ RXD)
64	SARTS	Output	Main Motherboard RTS Line To $MSpO_2$ Module ($MSpO_2$ CTS)
65	GND	Output	Digital Ground
66	+5V	Output	+5 V Logic Supply
67	GND	Output	Digital Ground
68	GND	Output	Digital Ground
69	PACER/	Input	Pace Maker Detection Signal
70	RXDB	Input	Main Motherboard RXD Line for $FSpO_2$ Module
71	RESFSP02	Output	Reset Line for Fetal Oximeter
72	No Connection	—	Reset Line for Fetal Oximeter
73	+15V	Output	+15 V Supply
74	+15V	Output	+15 V Supply
75	AGND	Output	Analog Ground
76	+15US	Output	+15 V Supply
77	+15V	Output	+15 V Supply
78	AGND	Output	Analog Ground
79	US1AUDIO	Input	Ultrasound Audio CH1
80	+10REF	Output	+10 V Reference From DSP Board
81	No Connection	—	—
82	FM	Output	Fetal Movement

Table 4-13. Front End Connector J1 (Continued)			
Pin Number	Signal Name	Signal Type (Relative to Main Motherboard	Signal Description
83	TELMAUDIO	Output	Telemetry Ultrasound Audio From Rear Panel
84	MECG 60DB	Input	MECG 60 dB Analog
85	AIN1	Input	Spare MUX Input Channel 3
86	No Connection	—	—
87	No Connection	—	—
88	No Connection	—	—
89	No Connection	—	—
90	AGND	Output	Analog Ground
91	No Connection	—	Isolation Barrier Pins
92	No Connection	—	Isolation Barrier Pins
93	No Connection	—	Isolation Barrier Pins
94	No Connection	—	Isolation Barrier Pins
95	No Connection	—	Isolation Barrier Pins
96	No Connection	—	Isolation Barrier Pins
97	GNDI	Output	Ground Input for Isolated Power Supply
98	GNDI	Output	Ground Input for Isolated Power Supply
99	+20I	Output	+20 Volts Input for Isolated Power Supply
100	+20I	Output	+20 Volts Input for Isolated Power Supply

Table 4-14. Emulation Test Port Connector J3			
Pin Number	Signal Name	Signal Type (Relative to Main Motherboard)	Signal Description
1	TMS	Input	Test Mode Select Line
2	TRST/	Input	Test Reset Line
3	TDI	Input	Test Data Input Line
4	GND	Output	Power Ground
5	+5V	Output	Presence Detect Line
6	No Connection	—	Connector Key
7	TDO	Output	Test Data Output Line
8	GND	Output	Power Ground
9	TCK-RET	Output	Test Clock Return Line
10	GND	Output	Power Ground Line
11	TCK	Input	Test Clock Input Line (10 MHz typical)
12	GND	Output	Power Ground
13	EMU0	I/O	Emulation Pin 0
14	EMU1	I/O	Emulation Pin 1

Table 4-15. Front Panel Interface Connector J4		
Pin Number	Signal Name	Signal Description
1	HR1VOLUP/	HR1 Volume Up Switch Input
2	No Connection	—
3	HR1VOLDN/	HR1 Volume Down Switch Input
4	TSW/	Trim Knob Push Button Switch Input
5	HR2VOLUP/	HR2 Volume Up Switch Input
6	RECLED1/	Recorder LED Drive Output
7	HR2VOLDN/	HR2 Volume Down Switch Input
8	RECLED2/	Recorder LED Drive Output
9	TEST/	Test Switch Input
10	GND	Power Ground
11	UA REF/	UA Reference Switch Input
12	GND	Power Ground
13	MARK/	Recorder Mark Input Signal
14	A/	Trim Knob Quadrature Switch Input Line
15	PADV/	Paper Advance Switch Input
16	B/	Trim Knob Quadrature Switch Input Line
17	RECON/	Recorder On Switch Input
18	ALRM CAN/	Alarm Cancel Switch Input
19	BP STRT*	NBP Start Switch Input
20	spare	Spare Input
21	BP STOP/	NBP Stop Switch Input (unused)
22	+5V	+5 Volt Power
23	GND	Power Ground
24	+5V	+5 Volt Power

Table 4-16. EL Panel Connector J5 (for 2001904-001 Board)		
Pin Number	Signal Name	Signal Description
1	+12EL	+12 Volt Power
2	GNDEL	Ground
3	GND	Ground
4	No Connection	—
5	+5V	+5 Volt Supply
6	GNDEL	Ground
7	VSYNCB	Vertical Sync Line
8	GNDEL	Ground
9	HSYNCB	Horizontal Sync Line
10	GNDEL	Ground
11	VCKB	Video Clock
12	GNDEL	Ground
13	VDATAB0	Video Data
14	GNDEL	Ground
15	VDATAB1	Video Data
16	GNDEL	Ground
17	VDATAB2	Video Data
18	GNDEL	Ground
19	VDATAB3	Video Data
20	GNDEL	Ground

Table 4-17. EL Panel Connector J5 (for 11888 Board)		
Pin Number	Signal Name	Signal Description
1	+12V	+12 Volt Power
2	+12V	+12 Volt Power
3	+5V	+5 Volt Power
4	+5V	+5 Volt Power
5	GND	Power Ground
6	GND	Power Ground
7	GND	Power Ground
8	GND	Power Ground
9	VSYNC	Vertical Sync Line
10	GND	Power Ground
11	HSYNC	Horizontal Sync Line
12	GND	Power Ground
13	VCK	Video Clock
14	GND	Power Ground
15	DATA	Video Data
16	GND	Power Ground

Recorder LED Board Interface

This section applies only to newer monitors with the built-in strip chart recorder light.

A single DSP Board signal (RECLED*) is routed through the switch panel to the Recorder LED Board (No. 2002570) to control LED current. This signal drives the base of a transistor acting as a high-side switch. When enabled, +5 V flows through each of seven parallel high-intensity amber LEDs and accompanying series current-limiting resistors to provide a light above the strip chart recorder.

NBP Board

Depending on when your monitor was manufactured, your unit may have one of three blood pressure boards installed:

- Manufactured by GE Medical Systems *Information Technologies* with DINAMAP blood pressure technology
- Manufactured by GE Marquette with Marquette Electronics blood pressure technology
- Manufactured by CAS Medical Systems, Inc. with CAS blood pressure technology

Refer to "Chapter 14, Replacement Parts" for NBP board part numbers.

NBP Board with DINAMAP or Marquette Electronics Technology

Pressure Transducer and Amplifier

The pressure transducer used in the NBP module is a Motorola SPX4053 (PS1) which is a 0 to 7.3 PSI sensor. The scale factor for this sensor is 10.595 µV/V/ mmHg. The transducer uses 10 Vdc to drive the sensor resulting in an output of 105.96 µV/mmHg. The transducer output is amplified by three stages of instrumentation amplifier U14 with a gain of 249.

DC Pressure Amplifier and Filter

The output of the pressure sensor instrumentation amplifier connects to a unity-gain two-pole 18 Hz low-pass filter (U14). The filter output connects to a DC amplifier (U13) which provides a gain of 1.9, and offsets the 0 mmHg pressure output to –9V. In the NBP module, the 10 V sensor drive is used as a reference to provide offset. The output of this amplifier stage provides the cuff pressure signal to the A/D converter and processor.

AC Amplifier and Filter

The output of the 18 Hz low-pass filter also provides the input to a two stage high-pass filter (U13) with gain and baseline restoration. Both stages are composed of a 0.7 Hz R/C high-pass filter buffered by a non-inverting amplifier. The first stage buffer amplifier has a gain of 82.6, and the second stage operates at unity gain. This filter chain extracts the small varying pressure signal caused by blood flow from the DC pressure signal to provide the pulse waveform needed to process the blood pressure measurement. The input of both buffer amplifiers (after the series high-pass capacitors) have FET switches (Q1, Q2) connected to ground. These switches clamp the inputs of the buffer amplifiers to ground when activated. The switches are activated during valve operation to prevent large signal transition from occurring in these stages when air is released from the cuff. The effect also provides a baseline restoration to 0 V at the output of these stages. Control of these FET clamps are from a processor output port through a transistor level shifter. The outputs of the high-pass stages connect to a two-pole 12 Hz unity gain low-pass filter (U13), which further restricts the AC passband. The composite 3 dB passband points with both high-pass and both low-pass filters is 1 Hz and 11 Hz. After the output of the low-pass filter, the signal divides into two paths. One path provides a unity gain (U12) to the A/D for higher level signals; the other provides a gain of 5 (U12) for lower amplitude signals. Both of these outputs, along with the DC pressure signal, are

connected to the A/D converter through three FET switches used to select an input for conversion.

MUX and A/D

The MUX is composed of a DG444 quad FET switch pack (U15). Three switches in this device are used. The drain leads connect to the individual input signals, and the sources connect together and go to a unity gain noninverting amplifier (U12). Control for each switch comes from individual port output lines from the processor. The amplifier output provides the A/D input. The A/D is a Burr Brown ADS7806 12-bit converter (U11) with an 8-bit processor output and a configurable input voltage range. The input voltage range for this application is selected to be ±10 V. The processor reads the high byte on even addresses, and the low byte on odd. Conversion is started by a write to the A/D read address. The BUSY line from the A/D which indicates a conversion in process, connects to an input port of the processor. The A/D also contains a precision 2.5 V reference which is used to generate the 10 V bridge drive and pressure offset voltage. The 10 V is generated from the 2.5 V using a non-inverting amplifier (U12) with a gain of 4 and an output transistor current driver (Q4).

Microcontroller and Host Interface

The microcontroller used in this circuit is a Motorola MC68332 (U10), configured for 8-bit bus operation. A total of 128 kB each of flash ROM and SRAM is installed on this board. The processor clock is provided using a 31.2 kHz crystal (X2) and the internal PLL circuitry of the controller. Power-on reset is provided by a Maxim MAX707 chip (U4). With the exception of the six I/O port lines used for MUX selection and the AC signal clamps, other control functions of devices like the valves and pump are done through the NBP ASIC (U9). The processor accesses this device through the 8-bit data bus. Host communications are provided by the SCI interface of the U10. It excepts/provides RS-232C formatted 5 V serial data. Communications formats are designed to provide functional equivalence to DINAMAP products.

Pump/Valve Control

Primary control of the pump and valves is done through the NBP ASIC (U9). This ASIC provides a timeout control for the pump and valves, overpressure pump/valve disable utilizing an external overpressure switch, and provides the processor access to sequence the valves on and off and control the pump's speed and activation. Three regulators (one for the pump and one for each of the two valves) that provide the supplies to the pump and valves are enabled by a control line from a processor port. Once the supplies are activated, sequencing of these devices is provided by output ports on the ASIC which control transistors switches. These transistors provide a ground return path for the activated device. In the case of a timeout or an overpressure fault, the ASIC will automatically shut off the pump and open the valves without processor intervention. Pump speed is controlled with the ASIC using output ports to control two transistor switches which change the feedback voltage to the pump regulator. The change in feedback voltage causes an increase or decrease in the regulator's output voltage which in turn controls the pump's output air volume.

NBP Board Manufactured by CAS Medical Systems, Inc.

This blood pressure module is manufactured by CAS Medical Systems, Inc. The following technical information is a summary of the module circuitry. This information is provided to give the hospital biomedical engineer an overall summary of the module's functions in relation to the 120 Series Monitor—to assist in isolating troubleshooting problems to the board level. This information is not intended to provide a complete circuit theory and should not be used to repair any problems on the board itself. When a problem does exist with the CAS Blood Pressure Board, contact your GE Service Representative for information about repair/exchange of the board.

Processor Circuitry

Eight-bit processor U1 controls all communication with the 120 Series Monitor through its integral serial port; it also controls the pump and valves, calculates the measurement results, and performs the board's self-test. The microprocessor has an internal clock divider that divides down the 9.216 MHz crystal-controlled clock to 4.608 MHz. One section of U6 also divides down the clock to provide 2.304 MHz to analog-to-digital (A/D) converter U4. Memory consists of 64k x 8 EPROM U2 and 8k x 8 bit RAM U3. Decoding of the processor's address lines is performed by U8, U9, U10, and U11 which select the EPROM, RAM, A/D, pump and valve drivers, and provide amplification control.

A/D Conversion

A/D converter U4 performs a 10-bit conversion that digitizes the signals representing static pressure in the cuff and cuff pressure caused by arterial volume changes. A 2.5 V reference is supplied by U5; a 5 V supply is provided by linear regulator U13 which converts the module's 12 V input to 5 V. The output of U4 is sent to the microprocessor for calculations.

Watchdog Circuitry

Watchdog functions are provided by U7 which performs three functions: if the software fails to execute properly, the watchdog resets the processor, disables the pump, and opens the valves; or if the module's 5 V power supply falls below 4.5 V, the watchdog will also reset the module; or if overpressure switch S1 detects a cuff pressure above 300 mmHg (40 kPa), it works in conjunction with U7 to reset the module.

Instrumentation Amplifier

Compensated pressure transducer U16, produces an output voltage that is proportional to the cuff pressure; the output is input to the instrumentation amplifier section. Amplifiers U14 and U15 amplify the pressure transducer's output and separate it into two channels. One channel has relatively low gain and represents the static pressure in the cuff. The other channel has higher gain and represents the cuff pressure changes caused by arterial volume changes. The outputs of the instrumentation amplifier are sent to the processor. The processor can disable the high gain channel during cuff deflation to prevent signal distortion.

Valves

Valves V1 and V2 vent the cuff's pressure to atmosphere. Two valves are required to permit safe depressurization in the event of a defective valve; valve V1 has a restricted orifice. The processor selects the appropriate valve to quickly and accurately deflate the cuff based on the cuff's volume and pressure.

Communications Board

NOTE: The 15297 surface-mount board, found in newer builds, replaces earlier 13388 versions. Functionally, the boards are the same.

The optional Communications Board performs three major functions:

- Central Systems Interface (J102)
- Model 2116B Keyboard Interface (J103)
- 340 Series Telemetry Interface (J101)

Central Systems Interface

This section consists of three digital-to-analog convertors (U1, U2, U5) and associated amplifiers (U3, U4, U7) to create the proper levels for modes, heart rate data, and uterine activity data; a reference generator (U8) which creates ±10 V; audio buffers (U9) for ultrasound channels one and two; and an output latch (U11) which provides the FMD1, FMD2, CHK PAPER*, and MARKOUT* digital signals. The mode signal levels are created by dual DAC U1, and one section of DAC U2. The output of each DAC is converted to a voltage by U3 (pin 1), U3 (pin 16), and U4 (pin 1) op-amps. The voltage range at that point is 0 to +10 V for a programmed value of 0 to FF respectively. The next stage (output) of op-amps U3 (pin 7), U3 (pin 10), and U4 (pin 7), level shift and invert the signal, providing a +10 V signal for a programmed value of zero, and –10 V signal for a programmed value of FF. The final output is filtered and protected by series resistors. The HR1 and HR2 outputs use DAC U5. The output of the first stage, U7 (pin 1) and U7 (pin 16), range from 0 V to –10 V with a programmed value of zero to FF respectively. From this point, the signal is inverted with a nominal gain of 0.24 and level shifted by –1.2 V thus biasing the signal to ±1.2 V. The level shifting pots (R18, R27), and gain adjustment pots (R20, R29), are used to ensure the proper accuracy of ±1 bpm. The level shifting for Hewlett Packard (HP) Central Systems is accomplished by opening the +10 reference to the offset pots R18 and R27. This takes out the +1.2 V offset thus creating a 0 to 2.4 V signal. The final output is filtered and resistor protected. The UA circuit operates similar to the HR circuit in Corometrics mode. For HP levels, the offset is again removed from the reference circuit using the same digital switch (S1) as for HR1 and HR2. Gain for HP levels must be changed to accomplish a 0 to +10 V range. To do this, two switches were added (S2, S3) in the feedback of U4 (pins 10,11). Switch S2 selects the gain for Corometrics levels and switch S3 selects the gain for HP levels.

Model 2116B Keyboard Interface

The keyboard interface consists of a data latch (U7), a status receive buffer (U8), a control latch (U6), and a PAL device (U15). Data is latched into U7 by an inverted version of the incoming STB* signal. This signal is inverted in the PAL device. The STB* signal is buffered through U8 before going to the PAL device for static protection. Once the STB* signal goes low, the PAL device IBF output goes high (tells keyboard that the monitor cannot accept any more data). After the STB* line goes high, the PAL-generated DATAVA* signal (goes to U8 status port) is read by the processor signaling that data is available. The processor then reads the data by pulsing the DATARD* line to U7. The PAL device then sets the DATAVA* line high. The IBF line to the keyboard goes low (signaling to the keyboard that the monitor can accept more data) when the processor clears the IBF latch. This gives the processor time to read the data and activate the INVLD* line if the nibble was bad before the next nibble is sent. Control information is sent to the keyboard via three lines from latch U6. A KBDRST* line resets the keyboard, a KBDBUSY* tells the keyboard to put up a busy message (due to recorder being off or busy printing previous message), and a KBDINVLD* tells the keyboard that the monitor received an invalid message. The status lines from the keyboard consists of a KBDIN* line which signals that the keyboard is plugged in, and a KBDMARK* line which pulses for a one-second minimum to print an event mark. These lines are read through buffer U8.

The +5 V power for the keyboard is created from VR1 using the +12 V source. This is done for static protection and for reliability reasons.

Model 340 Telemetry Interface

The telemetry interface consists of eight digital input status/mode lines and four analog inputs. The analog lines (TECG, TMECG, TELMAUDIO, TTOCO) are all passed to the Main Motherboard which in turn feed the DSP Board and Ultrasound Board. The eight status lines are buffered and read by the main processor.

Table 4-18. Central Systems Interface Connector J102			
Pin Number	Signal Name	Signal type (Relative to Communications Board)	Signal Description
1	HR2MODE	Output	HR2 Analog Mode Line
2	UA	Output	UA Analog Out
3	AGND	Output	Analog Ground
4	No Connection	—	—
5	+15V	Output	+15 Volts (Low Current)
6	No Connection	—	—
7	HR1	Output	Heart Rate One Analog Out
8	BAUD2OUT	Output	Ultrasound Audio CH1
9	BAUD1OUT	Output	Ultrasound Audio CH2
10	No Connection	—	—
11	No Connection	—	—
12	+5V	Output	+5 Volts (Low Current)
13	No Connection	—	—
14	FMD1	Output	Fetal Movement Detection CH1
15	FMD2	Output	Fetal Movement Detection CH2
16	No Connection	—	—
17	HR1MODE	Output	HR1 Analog Mode Line
18	CHK PAPER*	Output	Check Paper Out
19	No Connection	—	—
20	MARKOUT*	Output	Mark Out
21	No Connection	—	—
22	HR2	Output	Heart Rate 2 Analog Out
23	No Connection	—	—
24	UA MODE	Output	UA Mode Line

Table 4-19. Model 2116B Keyboard Connector J2			
Pin Number	Signal Name	Signal type (Relative to Communications Board)	Signal Description
1	GND	Output	Ground
2	GND	Output	Ground
3	+5V	Output	+5 V
4	KBDBUSY*	Output	Busy Signal Sent to Keyboard when Monitor is Busy
5	KBDINVLD*	Output	Sent to Keyboard when Monitor Receives Invalid Message
6	KBDRST	Output	Resets Keyboard
7	KBDMARK*	Input	Mark Signal from Keyboard
8	KBDIN*	Input	Keyboard Asserts this Line to Indicate its Presence
9	KBD0	Input	LSB of Keyboard Data
10	KBD1	Input	Bit 1 of Keyboard Data
11	KBD2	Input	Bit 2 of Keyboard Data
12	KBD3	Input	Bit 3 of Keyboard Data
13	KBD4	Input	Bit 4 of Keyboard Data
14	IBF	Output	Input Buffer Full from Monitor
15	STB*	Input	Strobe from Keyboard— Data Latched on Rising Edge

Table 4-20. 340 Series Telemetry Connector J2			
Pin Number	Signal Name	Signal type (Relative to Communications Board)	Signal Description
1	TMARK*	Input	Telemetry Mark Line—Active Low
2	TELPR*	Input	Telemetry Present—Active Low
3	TFECGEN*	Input	Telemetry FECG Enable—Active Low
4	TMECG	Input	Telemetry MECG
5	TECG	Input	Telemetry ECG Analog
6	TTOCO	Input	Telemetry TOCO Analog
7	AGND	Output	Analog Ground
8	TELMAUDIO	Input	Telemetry Audio
9	DGND	Output	Digital Ground
10	TMECGEN*	Input	Telemetry MECG Enable—Active Low
11	TTOCOEN*	Input	Telemetry TOCO Enable—Active Low
12	TUSEN*	Input	Telemetry US Enable—Active Low
13	TIUPEN*	Input	Telemetry IUP Enable—Active Low
14	TLEADOFF*	Input	Telemetry Leads Off—Active Low
15	No Connection	—	—

System Power Supply

NOTE: The 2005845-001 power supply, found on newer builds, replaces earlier 13836 versions. The newer version has a higher current output on the +5V line.

The power supply module in the 120 Series Monitor is manufactured by Power Controls, Inc. The following technical information is a summary of the power supply circuitry. This information is provided to give the hospital biomedical engineer an overall summary of the power supply's functions in relation to the 120 Series Monitor—to assist in isolating troubleshooting problems to the board level. This information is not intended to provide a complete circuit theory and should not be used to repair any problems on the board. When a problem does exist on the board, contact your GE Service Representative for information about repair/ exchange of the power supply assembly.

The power supply is an off-line high-frequency switching power supply designed to provide multiple regulated DC outputs from an AC source of supply. (The power supply assembly is manufactured by Power Controls, Inc.)

The power supply incorporates direct rectification and filtering of the mains voltage after fusing, in-rush limiting, and noise filtering are accomplished. An external selector switch is provided to choose between 120 V or 240 V operation. The input AC voltage need not be sinusoidal since no line frequency magnetic devices or sensing circuits are employed. Input connection is made via an IEC-style discrete line cord to allow adaptability to location of use.

The main DC output of 20 V is generated by high-frequency switching conversion in the current mode controlled forward converter method of operation. The frequency of operation is 72 kHz to which all post regulators are slaved and which is synchronized to the system clock. All outputs other than 20 V are derived using individual linear or buck type regulators to achieve voltage regulation current limiting and short circuit protection. Over-voltage protection is by transient voltage protectors on each output.

An exhaust fan is provided to move air through the entire system and out of the enclosure at the power supply.

Display Board

The display in the 120 Series Monitor is an electroluminescent (EL) glass panel with two circuit boards mounted on the back, referred to as the Controller Power Unit and the Driver Board. (The display assembly is manufactured by Planar Systems, Inc.)

The following technical information is a summary of the display circuitry. This information is provided to give the hospital biomedical engineer an overall summary of the display's functions in relation to the 120 Series Monitor—to assist in isolating troubleshooting problems to the board level. This information is not intended to provide a complete circuit theory and should not be used to repair any problems on the boards themselves. When a problem does exist with either board, contact your Corometrics Service Representative for information about repair/exchange of the entire display assembly.

The Controller Power Unit provides the required operating voltages. The Driver Board provides the 120 Series Monitor with front panel visual indicators for displaying all monitoring modes and numeric values. The electroluminescent display is a 320 column by 256 row flat panel with a resolution of 80 pixels per inch. The pixel aspect ratio is 1:1. A pixel is defined as the intersecting area between the column and row electrode.

The Controller Power Unit contains an integrated dc-to-dc converter which accepts the Vcc1 and Vcc2 supply voltages from the DSP Board. Voltage Vcc1 (+5 V) is used for the logic on the two display boards. Voltage Vcc2 (+12 V) generates the high voltage section—not to exceed 195 VAC.

The four basic operational signals (VID, VCLCK, HS, VS), needed to control the EL panel, are handled by the Driver Board after being processed on the DSP Board. These signals originate on the DSP Board from graphics generator U13. The vertical sync signal (VS) controls the vertical position of the picture. The horizontal sync signal (HS) is used to bracket the active pixel data for a horizontal scan line—the 320 bits of data from the VID line. The video clock signal (VCLK) is used to serially shift VID into the display; data latching occurs on the rising edge of the VCLK signal. Video data (VID) contains the serial pixel information to be displayed. A pixel is lit as voltage is applied to the specific row and column electrodes. Data is supplied from left to right and from top to bottom. Bit number one is displayed as the pixel located in the top left corner of the display; bit number 320 is displayed as the pixel located in the top right corner of the display; and bit number 321 is displayed as the pixel located directly beneath bit number 1, etc.

Dual Ultrasound Board

Overview

The Ultrasound Board is a dual channel pulsed Doppler ultrasound system with Channel A and Channel B. Each channel generates a 1.151 MHz (center frequency) pulsed carrier signal. This carrier signal causes the crystals in the transducer to emit ultrasonic sound waves. When these sound waves enter the maternal abdomen, they create echoes when encountering an interface between tissues of differing acoustic impedance. If the interface is moving either toward or away from the ultrasound transducer, the frequency of the reflected sound differs from the frequency sent from the transducer.

The Ultrasound Transducer

When the reflected sound wave is received by the transducer crystals, it is converted to an electrical signal. After being amplified, detected, and filtered, this signal is split into two paths: ultrasound audio and ultrasound envelope. The audio signal is sent to the Main Motherboard to be amplified for driving the speaker, while the ultrasound envelope is sent to the DSP Board for heart rate processing.

The center frequency of the transmitted carrier is 1.151 MHz with a pulse repetition frequency of 4 kHz (single channel use) or 2 kHz per channel (dual channel use). The total transmit and receive process is 250 µs which is broken down as follows:

- 90 µs: transmit pulse-wave Doppler
- 40 µs: wait state
- 90 µs: receive reflected signals
- 30 µs: idle state

When both ultrasound channels are being used, Channel A will complete a 250 µs cycle while Channel B is muted; then Channel B will complete a 250 µs cycle while Channel A is muted.

Ultrasound Oscillator

The main clock used to derive the ultrasound carrier frequency, as well as the transmit and receive timing is the ultrasound oscillator. The ultrasound oscillator is formed by the 4.604 MHz crystal X1, three inverters in U18, the timing components C124, C125, and C149, biasing resistors R153, R155 and R156, coupling capacitor C126, and two low-pass filters consisting of R154/C123, and R178/C150. The frequency of the oscillator is precisely set by the adjustment of capacitor C125. The output of the oscillator (U18, pin 6) provides the clock for counters U19, U21, and U22, which generate the timing signals used by the remainder of the digital control section of the board.

Digital Control Section

The digital control section of the Ultrasound Board is common to both Channel A and Channel B and is composed of ultrasound oscillator U18, PALs U20 and U23, and counters U19, U21, U22, and U24. Counters U19, U21, and U22 count down from the oscillator providing sequencing inputs to PALs U20 and U23, as well as the 144 kHz and 72 kHz clocks used to synchronize the monitor's switching power supplies. The PALs U20 and U23 decode the counter inputs to produce output signals that control the ultrasound transmitter (TRANS), select the active transducer (PIN1* and PIN2*), provide the detector carrier (DETQ and DETQ*), and switches the detector output to the Channel A or Channel B filters (CH1* and CH2*). An inverted version of the 4.604 MHz clock is used to clock the registered outputs of PAL U23 giving the inputs one half clock cycle to settle before the outputs are switched.

Signals A* and B* are additional inputs to PAL U20 and U23 and provide information on the number of transducers connected to the monitor. If only one ultrasound channel is selected, U23 outputs the appropriate signals for that channel only, at a pulse repetition frequency of 4 kHz. If both ultrasound channels are selected, the rate for each channel is 2 kHz. This repetition rate is determined by the states of A* and B* as well as the state of the signal USMODE.

The signal USMODE is generated by counter U24 and used by PAL U23 when both Channel A and Channel B are selected. The USMODE signal is ignored if only one channel (A* or B*) is selected. When A* and B* are both active, the state change of USMODE every 1024 clock cycles will alternately activate signals PIN1* and PIN2*.

Signals PIN1* and PIN2* are used to control the pin diode switches which in turn selects which of the two channels is active for transmitting and receiving.

The signal TRANS is a gated square wave with a frequency of 1.151 MHz which controls the ultrasound transmitter circuitry. It is initiated four clock cycles after reset and continues up to 428 clock cycles.

The signals DETQ and DETQ* are gated square waves of 1.151 MHz which are 180 degrees out of phase with each other, and provide both phases of the detector carrier required by the balanced ring demodulator. The signals begin 640 clock cycles after the counter chain is reset and continue up to 1020 clock cycles.

CH1* and CH2* control the switching of the output of the demodulator to the track and hold filter of Channel A and Channel B, respectively. They are controlled by A*, B*, and USMODE (similar to PIN1* and PIN2*), however they are switched active low from 640 to 1020 clock cycles following the same active timing as DETQ and DETQ*.

U23, pin 12, goes to a low state every 1151 clock cycles which resets the binary counters U19, U21, and U22 restarting the timing decoders at state 0.

Mode control signals (A*, B*, TEST*, and TELMCON) for the digital section of the ultrasound board are generated on the DSP Board and latched from the processor data bus by U15. U16, pin 6, provides the latch clock by decoding a processor chip select (CS0*) and the processor write pulse (BWR*). Mode information (US1EN*,US2EN*, and USMODE) is read by the processor through buffer U17. The output enable for U17 is generated by U16, pin 8, which decodes CS0* and the processor read pulse (BRD*).

The actual switching of the ultrasound input/output to the two transducers is accomplished using PIN diodes D1–D4. The signals PIN1* and PIN2* control the switching of quad analog switch U25 which routes +6 V and –6 V to resistors R1 and R2 and consequently bias the PIN diodes on or off. The ±6 V are derived from ±12V regulators VR3 and VR4 through a series of R/C filters which removes any noise present on these supply lines.

Channel A Pin Diode Circuitry

If Channel A (US1) is selected, R1 is biased to –6 V and R2 is biased to +6 V. The anode of D1 is held at ground potential by L5. The cathode of D1 will therefore be at approximately –600 mV since it is forward biased by the current through R1. The anode of D2 must then be at ground potential due to the –600 mV at its cathode. The current through D2 will be approximately 15 mA since the +6V applied to the anode of D2 is through a 402 Ω resistor R3 (6V/402¾ = 14.9 mA). D3 and D4 will be off at this time since their cathodes are at +6 V and their anodes are at 0 V. The 15 mA flowing through D1 and D2 stores charge in them which is an order of magnitude greater than will be depleted when the transmitter drives the transducer. Thus, even though the transmitter has large voltage excursions, D1 and D2 will remain on and provide a low impedance path between the transmitter and the transducer. During reception of signals, these diodes provide a low impedance path to the pre-amplifier.

Channel B Pin Diode Circuitry

If Channel B (US2) is selected, the process works the same except R2 is biased to –6 V and R1 is biased to +6 V, turning on diodes D3 and D4 and turning off diodes D1 and D2.

Transmission, Channel A or Channel B

Two channels are implemented; however, both channels share part of the same signal path. The ultrasound transmitter circuitry is formed by transistors Q1, Q2, Q3, and Q4, and associated components. Transmission is initiated by the signal TRANS from PAL U23. The gated 1.151 MHz burst causes Q1 to turn on and off at that frequency. The resulting waveform at the collector of Q1 will vary in amplitude between 0 V (Q1 full on) and a positive voltage determined by the voltage division of the series combination of resistors R6–R8, and the setting of potentiometer R5. R5 is used to adjust the drive amplitude to the ultrasound transducer. This waveform is further buffered by the non-inverting amplifier circuit comprised of Q2, Q3, and Q4, and filtered by a series resonate circuit consisting of L3 and C9 which couples the amplifier output to the transducer.

Reception, Channel A or Channel B

Two channels are implemented; however, both channels share part of the same signal path. At the end of the TRANS cycle, the common receiver pre-amplifier used by both channels is activated. The receiver pre-amplifier consists of Q5, Q6, and Q7 and associated components. L2 and C12 form a resonant L-type matching network which provides an impedance match between the transducer and the pre-amplifier. This matching network provides a voltage gain of approximately 38 dB due to its low to high impedance transformation. Transistors Q5 and Q7 form a cascade amplifier with a gain of approximately 13 dB. Q7 is a dual FET which is connected in parallel to improve the signal-to-noise ratio of the pre-amplifier by 3 dB. The noise improvement occurs since the effective transconductance is doubled but the noise adds in quadrature. The output load of the pre-amplifier, at the collector of Q5 consists of inductor L1 and capacitor C14 which forms a parallel resonant tank circuit with an impedance of approximately 10 kΩ. Transistor Q6 splits the pre-amplifier's output providing a 0 degree and 180 degree differential output to switch U11. Diodes D6 and D7 protect Q7 and clamp the voltage across C12 during transmission. Diodes D8 and D9 limit the voltage across capacitor C14 and speed overload recovery.

Quad high-speed analog switch U11 is configured as a balanced ring demodulator, and is used by both channels. The RF input to the demodulator comes from the pre-amplifier's differential outputs at the collector and emitter of Q6. Signals DETQ and DETQ* cause U11 to alternately switch the differential input signals to the two detector (differential) outputs at the same frequency as the transmitted signal. The resultant differential output at capacitors C21 and C22 will be proportional to the input amplitude at a frequency which is the difference between the input frequency and the frequency of the DETQ and DETQ* signals. Any input signal at the same frequency of the DETQ and DEQ* signals will produce either 0 V or a DC voltage between capacitors C21 and C22. Offset frequencies caused by the Doppler shift will produce an output at a frequency equal to the Doppler shift. The differential detector output at C21 and C22 is buffered by two non-inverting stages of U6. These buffered outputs are converted to single-ended output by a difference amplifier consisting of a stage of op-amp U6, which also provides a gain of 26 dB. Due to the alternating signals between transmit and receive, the detector output is active only one-third of the time. During the switch-off time, capacitor C21 is discharged by R20 and R21 while C22 is discharged by R22 and R23 to avoid crosstalk between Channel A and Channel B since the signals for both channels are multiplexed over the same signal path.

U6 drives analog switch U4 through R28. Signals CH1* and CH2* steer the demodulated output to the appropriate filter channel (Channel A or Channel B) when U11 is active. Switch U4 is kept inactive when U11 is inactive. Capacitor C23 holds the demodulated signal amplitude for Channel A between samples; C54 holds the demodulated signal amplitude for Channel B between samples.

When a telemetry system is connected to the monitor, the output from U4 to the Channel A filters is disconnected by a FET switch in U5. The ultrasound audio from the telemetry system is instead connected directly into the Channel A filters by a second switch in U5.

Channel A Filtering

NOTE: The remaining circuitry used on the ultrasound board is non-multiplexed, but is duplicated for each channel. Therefore; the theory discussed in the remainder of this document, although referencing only Channel A, shall apply to Channel B as well.

Main Filters

The main filters for Channel A are band-pass filters consisting of four stages (two, 2-pole low-pass; two, 2-pole high-pass) of U3 and associated components. The 3 dB points are at 100 Hz and 300 Hz with rolloffs of 24 dB/octave for both high and low frequencies. A variable resistor (R37) is used to set the overall gain between the detector output and TP1 to 32 dB. The output of the main filter (U3, pin 7) is then split between the ultrasound audio circuitry and the ultrasound envelope circuitry.

Audio Circuitry

To obtain the Channel A ultrasound audio, the output of the main filter connects to a full-wave precision rectifier consisting of two sections of U1 and associated components. The output resulting from the full-wave rectification is a frequency doubling of the original waveform. The frequency doubled output is then band-pass filtered by a passive low pass (R57/C44), a passive high-pass filter consisting of C45, C46, and R59, and an active low-pass using one section of U7, which also provides a gain of 35. The output is then buffered by a second section of U7 which provides the US1 AUDIO output to the Main Motherboard.

Ultrasound Envelope

To generate the Channel A ultrasound envelope, the output of the main filter is amplitude scaled by resistive divider R180/R48 and then connected to compandor (U2) which provides at least 40 dB of signal compression. The output from the compandor is limited by diodes D18–D19 and then precision rectified by a stage of U1 and its associated components. The gain of the rectifier is adjustable over a range of 7 to 17 using R183 to accommodate the possible output variations of U2. The rectified output is then low-pass filtered by a 20 Hz active filter with a gain of 10, consisting of a stage of U1 and its associated components. The output of the filter is a unipolar signal which follows the low frequency amplitude variations (or envelope) of the output from the AGC chip. The filter is biased for an output of –10 V with a no input signal condition. This provides the –10 V to +10 V input required by the A/D converter on the DSP Board. The US1 ENV output from this filter connects to the DSP Board for heart rate processing.

Fetal Movement Filters

The input to the Channel A main filter also connects to the Channel A fetal movement filters. These filters consists of a unity gain non-inverting buffer amplifier from the detector output, two unity gain active 2-pole high-pass filters, two unity gain active 2-pole low-pass filters, and an inverting amplifier from a stage of U12 with an adjustable gain of 2.7 to 14. Input potentiometer R126 sets the amplifier gain. The 3 dB points are at 15 Hz and 39 Hz with rolloffs of 24 dB/octave for both high and low frequencies. The output at U12, pin 1 (FMD1) connects to the DSP Board for movement detection processing.

UA/FECG Board

Isolated FECG Circuitry

The isolated FECG section of this board consists of instrumentation amplifier U16, amplifier U3, and right leg drive amplifiers U11. The right arm and left arm signals from the patient are differentially amplified by U16 which provides a gain of 10 and a single-ended output for the following stage. The output of U16 is high-pass filtered at 1 Hz by the combination of C39, a 0.33 µF capacitor, and R58, a 499 kΩ resistor. Diodes D9 and D10 provide a rapid discharge path for C39 when the output of U16 exceeds 0.6 V. This improves base line recovery time of the FECG output during extreme base line shifts or fault conditions. After being high-pass filtered, the ECG signal is further amplified by U3 which provides an additional gain of 100. The total gain of the FECG front end is 1000 or 60 dB.

The summing points of the instrumentation amplifier U16 at pins 1 and 8 represent the voltage present at the input leads. This voltage is combined by resistors R115 and R116, which provides the sum of the voltages at these two pins. For normal differential signals, the voltage at these pins are of equal amplitude but opposite polarity, which causes the output of the resistors to be 0 V. Common mode signals however are of the same polarity and add together at the output. This common mode voltage from the resistor network is buffered by the first stage of U11. This voltage is inverted and integrated by the second stage of U11, which is fed back to the patient as the right leg drive signal. The 332 kΩ output resistor used on this stage is used to limit the output current the stage is able to deliver to the patient under fault conditions.

The two 22 MΩ resistors, R51 and R52, connected to the input leads and to the –15 V supply, provide “leads off” detection for the FECG amplifier. When the ECG electrodes are not connected to the patient, these resistors pull the inputs of the instrumentation amplifier to –15 volts, saturating the input stages of this amplifier. The resulting output from U16 is forced to 0 V, which prevents the system from counting any noise or other signals when the leads are not connected. Connection of the leads to the patient enables the right leg drive to pull down the inputs to a normal operating range.

Resistors R112 and R114, and capacitors C34, C35, and C36 form a differential low-pass filter for the input of the FECG amplifier. This prevents high-frequency energy from affecting the operation of the amplifier, and limits the input current to U16. Diodes D5, D6, D7, and D8 limit the differential input voltage of U16 to ±1.2 V.

The output from the FECG amplifier is coupled from the isolated circuitry to unisolated circuitry by isolation amplifier U2. This device is a capacitive coupled VCO/PLL type design that provides unity gain output with a frequency response of DC to about 500 Hz and has a breakdown voltage of 8000 V-pk. The output from U2 is low-pass filtered at 90 Hz by a two-pole filter consisting of U1, C52, C54, R75, and R76. The filtered output is further amplified by another stage of U1 that provides a non-inverting gain of 10 for the 80 dB FECG output that connects to the rear panel jack of the monitor.

The filtered output also drives two other circuit blocks that provide the different filtering and gain adjustments necessary to do either FECG or MECG processing from the same front end amplifier. The last two stages of U1 perform the filtering and gain correction for the FECG processing. The first stage consists of U1, C58, C59, C60, R82, R83, and R84 which form a 3-pole 20 Hz high-pass filter. The last stage of U1 amplifies the output from the high-pass filter by providing a gain of 15. This output connects to the DSP Board for signal processing and rate detection.

Isolated UA Circuitry

The isolated UA section of this board consists of an instrumentation amplifier U12, amplifier and low-pass filter from two sections of U22, a 12-bit serial A/D converter U9, and a precision 4 V bridge power supply from another section of U22. The differential output from the IUP or TOCO bridge is amplified by the instrumentation amplifier U12 which has a gain of 100. The output of U12 is additionally amplified by a stage of U22 with a gain of 15, making the total gain of the UA front end 1500. After amplification, the UA signal is filtered by a unity gain two-pole 10 Hz low-pass filter consisting of U22, R16, R17, C9, C10, and C11. The output from the low-pass filter connects to the input of a 12-bit serial A/D converter, U9. The converter is configured for an input range of ±10 V. At the falling edge of the A/D convert pulse, the input level to the A/D is held and a conversion is started. Some time after the start of conversion (approximately 450 ns), the A/D will begin generating the 12 clock pulses and synchronized data to serially shift out the results from the previous conversion. The supply for the IUP or TOCO bridge is derived from the 2.5 V reference in the A/D converter. This is amplified by a stage of U22 to 4.00 V with transistor Q1 providing current gain to enable the supply to provide the drive necessary for the bridge. With a 4 V drive, the scaling of the bridge is 20 µV/mmHg.

Resistor R3, R4, R5, R6, and capacitors C1, C2, and C3 comprise a differential low-pass input filter for the bridge amplifier U12. This keeps high frequency energy from effecting the operation of this stage. D1, D2, D3, and D4 limit the differential input voltage to U1 from exceeding ±1.2V.

The serial data from the A/D is transferred from the isolated circuitry to the unisolated circuitry by the use of opto-isolators. The A/D clock and data are buffered by gates in U15 which in turn drive the LED side of dual opto-isolator U14. The restored clock and data on the output side of this isolator is sent to the DSP Board where the data is converted to a parallel format that the processor can access. The convert pulse used to start the A/D conversion is generated at the DSP Board. This signal is transferred to the isolated circuitry by another dual opto-isolator U6. The output from U6 is buffered by two stages of U15 before connecting to the R/C* input of the A/D.

By using the serial clock generated in the A/D, additional data is clocked between the isolated and unisolated circuitry using serial in/parallel out and parallel in/serial out shift registers. On the isolated side, U7 is parallel loaded with mode enables (FECG ENABLE*, TOCO EN*, etc) and other control signals when the R/C* line of the A/D is driven low to start a conversion. The serial clock from the A/D converter provides the clock signal for this part. As data is clocked from the A/D, data is also shifted out of U7. The QH output from U7 drives the LED side of opto-isolator U5, which transfers the serial data to the unisolated circuitry. While data is being shifted from the A/D and from U7, serial data transferred from the unisolated circuitry by opto-isolator U7 is clocked into U8, which also shares the common serial clock. After the data has been shifted into the shift register section of U8, the next convert pulse to the A/D will transfer the shift register outputs to the output latch section of this part. The latched outputs of U8 provide control signals for the option MECG board. On the unisolated side, shift register U19 is parallel loaded by the DSP processor. The load pulse for U19 is decoded from a processor chip select and write pulse by gate U23. The A/D serial clock, available through U14 on the unisolated side is used to shift the data from U19 via opto-isolator U6 to U8 on the isolated side. Only the lower four bits of the 8-bit byte are used by the isolated circuitry. The upper four bits are retained on the unisolated side by latch U18, which is loaded from the same decoded load pulse as U19. Two of these bits are used on the unisolated side to control the selection of FET switch U17, and to provide a control signal for the option MECG board to configure it for 50 or 60 Hz operation. Data coming from U7 on the isolated side is clocked into shift registers U20 and U21 using the common serial clock available to the unisolated circuitry. As with U8, data is transferred from the shift register section of these parts to the output latch section when a convert pulse is generated. The output latches are tri-state and connect to the processor data bus. The output enable for these parts is generated by decoding a chip select and read signal from the processor by a gate in U23.

Table 4-21. Front End Motherboard Connector J1		
Pin Number	Signal Name	Signal Description
1	No Connection	—
2	No Connection	—
3	AGND	Analog Ground
4	MECG1EN*	MECG Mode Enable
5	EXCITREF	+4 V Reference Ground
6	BRGEXCIT	+4 V Reference
7	PRESS–	Negative Input to Pressure Amplifier
8	STRAIN GAUGE*	IUP Mode Enable
9	AGND	Analog Ground
10	FRA	Fetal Right Arm Input
11	No Connection	—
12	B EN*	Mode Input (Unused)
13	FECG ENABLE*	FECG Mode Enable
14	MECG2 ENABLE*	Model 116 MECG Mode Enable
15	AGND	Analog Ground
16	PRESS+	Positive Input to Pressure Amplifier
17	TOCO*	TOCO Mode Enable
18	SENSE	Spare Analog Input
19	FLA	Fetal Left Arm Input
20	FRL	Fetal Right Leg Drive

Table 4-22. Front End Motherboard Connector J3		
Pin Number	Signal Name	Signal Description
1	+5V	+5 V Logic Supply
2	BD6	Status/Control Bus Bit 6
3	BD7	Status/Control Bus Bit 7
4	CSO*	Status/Control Bus Chip Select 0
5	CS1*	Status/Control Bus Chip Select 1
6	CS2*	Status/Control Bus Chip Select 2
7	CS3*	Status/Control Bus Chip Select 3
8	+5V	+5 V Logic Supply
9	BRD*	Status/Control Bus Read Line
10	BA1	Status/Control Bus Address Line Bit 1
11	RES*	Reset Line
12	RESFR*	Unused
13	No Connection	—
14	72KHZ	72 kHz Sync Clock
15	+5V	+5 V Logic Supply
16	No Connection	—
17	+5V	+5 V Logic Supply
18	IUP CLK	IUP Clock
19	CVRT*	IUP Start Conversion Line
20	IUP DATA	IUP Serial Data
21	AGND	Analog Ground
22	AGND	Analog Ground
23	–15V	–15 V Supply
24	–15V	–15 V Supply
25	AGND	Analog Ground
26	AGND	Analog Ground
27	–15V	–15 V Supply
28	AGND	Analog Ground
29	—	—
30	—	—

Table 4-22. Front End Motherboard Connector J3 (Continued)		
Pin Number	Signal Name	Signal Description
31	AGND	Analog Ground
32	AGND	Analog Ground
33	No Connection	—
34	FECG	FECG Analog
35	FECG 80 DB	FECG 80 dB Analog
36	No Connection	—
37	No Connection	—
38	FECGRAW	FECG Raw Analog (Unused)
39	No Connection	—
40	AGND2	Analog Ground
41	No Connection	—
42	No Connection	—
43	No Connection	—
44	No Connection	—
45	No Connection	—
46	No Connection	—
47	No Connection	—
48	–15VISOL	–15 V Isolated Supply
49	ISOGND	Isolated Ground
50	+15VISOL	+15 V Isolated Supply
51	+5V	+5 V Supply
52	BD0	Status/Control Data Bus Bit 0
53	BD1	Status/Control Data Bus Bit 1
54	BD2	Status/Control Data Bus Bit 2
55	BD3	Status/Control Data Bus Bit 3
56	BD4	Status/Control Data Bus Bit 4
57	BD5	Status/Control Data Bus Bit 5
58	+5V	+5 V Supply
59	BWR*	Status/Control Bus Write Line
60	BA0	Status/Control Bus Address Line Bit 0
61	No Connection	—

Table 4-22. Front End Motherboard Connector J3 (Continued)		
Pin Number	Signal Name	Signal Description
62	No Connection	—
63	No Connection	—
64	No Connection	—
65	+5V	+5 V Supply
66	+5V	+5 V Supply
67	+5V	+5 V Supply
68	+5V	+5 V Supply
69	PACER*	Pacemaker Detection Signal
70	No Connection	—
71	No Connection	—
72	No Connection	—
73	+15V	+15 V Supply
74	+15V	+15 V Supply
75	AGND	Analog Ground
76	+15US	+15 V Supply
77	+15V	+15 V Supply
78	AGND	Analog Ground
79	No Connection	—
80	+10REF	+10 V Reference
81	AGND	Analog Ground
82	AGND	Analog Ground
83	No Connection	—
84	MECG 60DB	MECG 60 dB Analog
85	AIN1	Spare MUX Input Channel 1
86	AIN2	Spare MUX Input Channel 2
87	AIN3	Spare MUX Input Channel 3
88	AIN4	Spare MUX Input Channel 4
89	AIN5	Spare MUX Input Channel 5
90	AGND	Analog Ground
91	No Connection	—
92	No Connection	—

Table 4-22. Front End Motherboard Connector J3 (Continued)		
Pin Number	Signal Name	Signal Description
93	No Connection	—
94	No Connection	—
95	No Connection	—
96	No Connection	—
97	No Connection	—
98	+15VISOL2	+15 V Isolated Power Supply
99	ISOGND2	Isolated Ground
100	–15VISOL2	–15 V Isolated Power Supply

Table 4-23. MECG Board Connector J5		
Pin Number	Signal Name	Signal Description
1	+15VISOL	+15 V Isolated Power Supply
2	–15VISOL	–15 V Isolated Power Supply
3	AGND	Analog Ground
4	MECG1EN*	MECG Mode Enable
5	LEADSOFF	Leads Off Detection Signal
6	SEL1	MECG Lead Select Bit 1
7	SEL2	MECG Lead Select Bit 2
8	PACEMAKER ON	Pacemaker Enable Line
9	+15ISOL	+15 V Isolated Power Supply
10	–15VISOL	–15 V Isolated Power Supply
11	AGND	Analog Ground
12	No Connection	—
13	TEST PULSE	MECG Test Waveform
14	BOARD INSTALLED*	MECG Board Installed
15	+5VISOL	+5 V Isolated Power Supply
16	No Connection	—

Table 4-24. MECG Board Connector J6		
PIN NUMBER	SIGNAL NAME	SIGNAL DESCRIPTION
1	MECG1	MECG Analog
2	50/60HZ	MECG 50/60 Hz Filter Control Bit
3	+15V	+15 V Supply
4	+15V	+15 V Supply
5	–15V	–15 V Supply
6	–15V	–15 V Supply
7	AGND	Analog Ground
8	AGND	Analog Ground

MECG Board

Defibrillator Protection

The defibrillator protection is primarily a function of neon bulbs DS1–DS3 and 1 kΩ resistors located in each lead of the ECG cable assembly. When the voltage on any patient lead exceeds 70 to 90 V with respect to isolated ground, the associated neon bulb will light, discharging the energy on the lead to isolated ground. The 1 kΩ resistors in the cable serve to limit the current through the bulbs to a safe level, and to prevent the circuit from absorbing too much of the total defibrillator current applied to the patient. The ECG amplifier is further protected by the 20 k¾ series resistors R4–R6 and limiting diodes D1–D6. These protection diodes are connected in pairs to each patient lead and to ±10 V references through resistors R7 and R8. These diode pairs will conduct when the input to any lead exceed the ±10 V reference levels. In conjunction with the series 1 kΩ resistors, these diodes will limit the input to the remaining circuitry to ±10 V. Capacitors C5–C10 are used to dampen the voltage variation to the ±10 V diode references caused by the high amplitude short duration waveforms normally associated with defibrillators.

Input Lead Switching

Lead switching is accomplished by a pair of dual analog multiplexes U14 and U13. The two input leads from the ECG instrumentation amplifier, and the right leg drive output stage each connect to an input of one of the three 1-to-4 MUX sections of U14 and U13. The two select lines (SEL1 and SEL2) for the both U14 and U13 connect to control circuitry located on the FECG/UA Board. The four outputs of the three MUX stages are wired for the following three combinations of lead selections:

- [SEL 1=0 SEL 2=0], –amp in to RA, +amp in to LA, right leg out to RL
- [SEL1=1 SEL 2=0], -amp in to RA, +amp in to RL, right leg out to LA
- [SEL1=0 SEL 2=1], -amp in to LA, +amp in RL, right leg out to RA.

A fourth selection [SEL1=1 SEL 2=1] bypasses the input connector and connects the two inputs and one output to an on board test generator.

Single-Wire ECG Amplifier with Right Leg Drive

The ECG amplifier itself consists of an instrumentation amplifier, an amplifier/limiter stage, a low-pass filter/output buffer stage, an integrator stage for the right leg drive, and an integrator stage for baseline restoration. Before connecting to any active circuitry, the patient signals from MUX U14 are first low-pass filtered by a differential filter consisting of resistors R19 and R22, and capacitors C15, C16, and C18. This filter prevents high-frequency energy from affecting the normal operation of the ECG amplifier. Resistors R23 and R24 are used to limit input current to the amplifier due to fault conditions. After filtering and passing through the protection circuitry, the patient signals connect to the inputs of instrumentation amplifier U7, which provides a gain of 10. The single-ended output of U7 connects to the input of an amplifier/limiter stage consisting of resistors R36–R39, op-amp U6, capacitor C33, and diodes D13–D18. R36, R37, D13, and D14 form an input limiter to this stage that prevents the input voltage to U6 from exceeding ±0.6 V. Since the maximum output of U7 under normal signal conditions is ±0.05 V, this limiter will only have an effect for overload conditions such as a pacemaker pulse input. U6 is configured as a non-inverting amplifier with a gain of 100. Even with the input limited to ±0.6 V, U6 would saturate under an overload condition. To prevent this, diodes D15–D18 in the feedback of op-amp U6 will cause the amplifier to revert to unity gain for output levels that exceed ±10.5 V. Zener diodes D17 and D18 have a breakdown voltage of 8.7 V. Depending on the polarity of voltage across them, one of the two zeners will be forward biased providing a 0.6 V drop. This makes the combine breakdown voltage of the pair 9.3 V. Back-to-back diodes, D15 and D16, add an additional 0.6 V to the total. With the input of U6 (pin 12) limited to ±0.6 V, the feedback point at pin 13 must also be limited to this same potential. By adding up the combination of breakdown voltages of the feedback diodes (9.9 V) and the maximum voltage at pin 13, the output must reach ±10.5 V before the limiting diodes conduct and short out R38, making U6 a unity gain amplifier. Both the input limiter, and the feedback limiter are used to reduce the overload recovery time of amplifier U6 from pacemaker spikes or other large signals. With the pacemaker rejection turned off, the output of U6 connects to a single-pole low-pass filter composed of R67 and C37 through FET switch U2. This filter has a 3 dB point of 59 Hz. The filter output is buffered by another op-amp of U6 which is configured as a unity gain non-inverting amplifier. The output of this buffer represents the final 60 dB output stage of the ECG front end circuitry. Since the entire amplifier chain is DC coupled, some form of high-pass function or DC correction is necessary to eliminate baseline offsets and to maintain the ECG signals within the dynamic range of the system. This is accomplished with an inverting integration stage composed of resistors R31–R35, capacitors C31 and C31, diodes D11 and D12, and op-amp U10. The final output of the ECG amplifier at U6 pin 8 is attenuated by resistor divider R31 and R34. This attenuation is necessary to adjust for the gain difference (x100) between the output of the limiter/amplifier stage at U6 and the offset feedback point which is the reference input to instrumentation amplifier U7 (pin 10). The output of the attenuator connects to an integrator stage which produces an output voltage that is proportional to the inverse of its input voltage and the amount of time the voltage is present. When the DC level at the output increases or decreases from 0 V, the integrator over time will produce a feedback voltage that restores the output to 0 V. Since the integration process is a function of time, the lower the frequency component applied to the input, the larger the voltage swing will be at the output. The effect of this is a cancellation of low-frequency signals at the output of the ECG amplifier chain. This makes the ECG amplifier appear to have a high-pass filter installed somewhere in the chain. The attenuator and time constants used in the integrator were selected to provide a –3 dB high-pass point of 0.6 Hz. Diodes D11 and D12 along with resistor R32 speed up the response of the integrator by

increasing its input voltage when the ECG output exceeds ±5.7 volts. This allows the baseline to be rapidly restored when the output offset becomes too large. The right leg drive is used to feed back to the patient, out-of-phase common-mode signals, in order to cancel out the effects of these signals.

The output of the two buffer stages in instrumentation amplifier U7 (pins 1, 8) represents the voltage present at the input leads times a gain of 10. For normal differential ECG signals, the voltage at these pins is of equal amplitude but opposite polarity. For common mode signals however, these pins are at equal amplitudes but the same polarity. Resistors R29 and R30 tie pins 1 and 8 of U7 to the summing point of the right leg drive integrator stage consisting of U10, C17, and R10. Since normal signals are of opposite phase at pins 1 and 8 of U7, the current supplied to the integrator through R29 and R30 is zero, resulting in 0 V output from the right leg drive. Common mode signals being at the same phase cause the currents to add and produce an output of opposite polarity to the common mode voltage. This out-of-phase common mode voltage connects to the patient through R14, a 332 kΩ resistor which limits the current delivered to the patient under a fault condition. The time constants used in the integrator were selected for optimum rejection of 50/60 Hz which is the most frequently encountered common mode noise.

Pacemaker Detection

Pacemaker signals are distinguished from normal ECG by the rate of change of the waveform. Pacemaker pulses have slew rates faster than 100 µs, while the slew rate of normal ECG signals are typically more than 100 times slower. The pacemaker detector uses this signal characteristic by differentiating the output of the amplifier/limiter stage U6 using a high-pass filter consisting of capacitor C28, resistor R50, and op-amp U5 to separate the pacemaker pulses from the ECG waveform. The high-pass function from C28 and R50 attenuates the ECG while allowing the pacemaker pulses to pass through with only minimal reduction in amplitude. The output of the differentiator is buffered by a section of U5 which is configured as a unity gain non-inverting amplifier. The buffered output connects to two comparators formed from two op-amps of U5, one with a positive threshold, the other with a negative threshold. The positive threshold (+1.0 V) is derived from the voltage division of the +10 V reference through resistors R49 and R52. The negative threshold (–1.0 V) is developed by inverting the positive threshold through the last stage of U5 configured as a unity gain inverting amplifier. When the differentiated output exceeds one of these thresholds, the associated comparator will toggle positive. The output of both comparators are ORed through diodes D19 and D20. When either comparator goes positive, the diode OR gate will turn on transistor Q1 which is used as a level translator from the +15 V output of the comparators to a +5 V logic level. The output from Q1 triggers monostable U3 which generates a 5 ms pulse that is used by the pacemaker rejection circuitry to gate out the pacemaker signal. When pacemaker rejection is enabled through a gate in U1, the signal path from the output of the limiter/amplifier at U6 is altered. The pacemaker enable comes from control circuitry on the FEGC/UA Board. Instead of connecting to the original R/C low-pass filter at FET switch U2, the signal from U6 instead is routed through U2 to an alternate single-pole low-pass filter composed of resistor R40 and capacitor C38. This filter has a –3 dB point of 100 Hz, however its primary function is to insert a small delay to the ECG signal to allow for the detection time required by the pacemaker detection circuitry. This low-pass filter directly drives a slew rate limiter consisting of diodes D21–D24, resistors R68, R69, capacitor C39, and a buffer amplifier from an op-amp of U6. To understand how the slew rate limiter works, the circuit needs to be analyzed from a static condition. With 0 V at the input of the filter there will be +0.6 V at the junction of D21 and D22, –0.6 V at the

junction of D23 and D24, and 0 V at the output across C39. Under these conditions, a conduction path exists between the input and the output of the limiter. When a step change occurs at the input, for example a +1 V step, diode D21 will become reverse biased turning off the current path from the input to the junction of D21 and D22, and to the output. Diode D23 conducts, raising by +1 V the potential at the junction of D23 and D24. This turns off diode D24, breaking the current path from the input and from R69 to the output. The only current path left is from R68 through D22 to the output capacitor C39. R68 begins to charge C39 at the rate determined by the time constants of the two parts until C39 reaches +1 V and the normal conduction paths are restored from input to output. This in effect will limit the output of signals that have faster slew rates then the time constants of R68 or R69 and capacitor C39. The output of the limiter is buffered by a unity gain non-inverting amplifier from an op-amp of U6. The output of this buffer connects through FET switch U2 to a single-pole 97 Hz low-pass filter composed of resistor R65 and capacitor C37. This filter is buffered by the common output stage from the op-amp of U6 that provides the output of the ECG amplifier. When the pacemaker detector gating pulse occurs, a switch in U2 opens the path between R40 and C38, which stops the charging of C38. C38 at this point will hold its last potential for the 5 ms gate period, maintaining a constant input to the slew rate limiter during this period. In a like manner, the output from the slew rate limiter buffer is disconnected by another switch in U2 from the low-pass filter of R65 and C37. Due to the very high input impedance of the final buffer stage of U6, C37 will hold its last potential, keeping the output constant during the gating period. In effect, the pacemaker rejection circuitry holds the ECG output at the voltage that was present at the output before the occurrence of a pacemaker pulse, until sufficient time has elapsed for the pacemaker pulse to terminate.

Leads Off Detection

The leads off detection relies on the equal DC biasing of the two patient input leads, along with canceling effects of the right leg drive to common mode signals. Resistors R17, R18, R20, and R21 apply a small DC common mode voltage to the input leads. Under normal operating conditions, the right leg drive generates an opposite potential that cancels out the effects of this voltage. However, when one of the two input leads are not connected to the patient, a difference voltage across the input leads is generated which equals the voltage drop across R21 or R20 through the series combination of R17 and R18. This difference voltage is amplified using the buffer stages from instrumentation amplifier U7 and a difference amplifier consisting of op-amp U10, resistors R43, R46–R48, and capacitors C24 and C26. This difference amplifier provides an additional gain of 1.8 over the gain of ten supplied by the U7 buffer section. Capacitors C24 and C26 role off the response of the amplifier to 3 Hz to prevent noise or large signals from affecting the operation of the detection circuitry. The single-ended output from U7, which is also a difference amplifier, is not used due to the baseline feedback connected to pin 10 which tries to restore U7's output to 0 V. If both leads are disconnected, the method of detection relies on the right leg drive providing a saturated output to the patient. The right leg drive, past limiting resistor R14 is buffered for detection by a unity gain non-inverting amplifier from one section of op-amp U10. If the right leg drive itself is the disconnected lead, it will also provide a saturated output trying to cancel the common mode input voltage. The actual leads off detection is done by a pair of comparators from two stages of op-amp U12. One comparator provides a positive output when its input exceeds a positive threshold derived from the voltage division of the +10 V reference across R73 and R75. The other provides a positive output when its input drops below a negative threshold set by the voltage division of the –10 V reference across R79 and R82. Diodes D25–D28 combine the outputs of the difference amplifier and the right leg buffer as well as separating the negative and positive excursions of these outputs for connection to the inputs of the two comparators. D25 and D26 connect the outputs of the difference amplifier and the right leg buffer when either goes positive to the positive threshold comparator. D27 and D28 connect these outputs to the negative threshold comparator when either goes negative. When either output exceeds the threshold of one of the two comparators, that comparator will toggle positive. Both outputs from the comparators are ORed by diodes D29 and D30 that turn on transistor Q2. Q2 provides a level conversion from the 15 V outputs of the comparators to a +5 V logic level. The output of Q2 connects to control circuitry on the FEGG/UA Board.

Test Generator

The test generator is composed of monostable U3 and an attenuation network consisting of resistors R104–R110. U3, by the values of resistor R111 and capacitor C54, is set to provide a 100 ms pulse every time it's triggered from a control line from the FECG/UA Board. When the input MUX is configured for the test generator, the attenuated output of U3 connects to the input leads of the ECG amplifier allowing for a board self test. The attenuation network scales the Q and Q* outputs of U3 providing a 1 mV differential signal source. R106 offsets the Q* output so that it is referenced to 0 V. R104 and R105 combine the right leg drive output with the output of the generator. The logic supply for the test generator, as well as all the other isolated logic is generated by an adjustable three-terminal regulator VR1 from the isolated +15 V supply.

Linear Isolation Amplifier

All of the circuitry discussed so far has been electrically isolated from the main system electronics. In order for the ECG output to get sampled and processed by the main system, it must somehow get coupled over to the un-isolated circuitry without effecting this electrical isolation. This is the function of linear opto-isolator U9. U9 consists of an LED and a pair of matched photodiodes. The LED is physically located in the part to provide equal light intensity to both of the photodiodes. One photodiode is used by the isolated circuitry, the other by the un-isolated. Since the photodiodes are matched, current flowing through one will equal the current flowing through the other, given the same supplies and load resistance. The isolation amplifier relies on this to provide the needed signal path across the barrier. The output from the last stage of the ECG amplifier is attenuated by two with resistors R84 and R85. This is needed to keep the LED/photodiode pair within its linear operating range. A stage of U6, along with current driver Q3, drives the LED section of the opto-isolator with the divided input signal. C44 in the feedback of U6 limits the slew rate of the op-amp to prevent oscillations caused by feedback delays associated with the opto-isolator. The anode of the LED connects to the emitter of Q3 which can sink current to the + 15 V supply through its collector resistor R87, and the cathode connects to the –15 V supply through R88. Feedback for U6 comes from the output of the isolated photodiode through a 100 kΩ resistor R101. The bias for the photodiode/feedback resistor is supplied by ±10 V references. These are generated by an inverting amplifier with a gain of two consisting of U12, R98–R100, and C51 (–10 V) and by a non-inverting amplifier with a gain of two consisting of another section of U12, R89–R90, and C47 (+10 V). The input used by both these reference amplifiers is U16, a +5 V precision voltage reference. U6 and Q3 drive the LED with the input signal, and the feedback from the isolated photodiode keeps the relationship between the input voltage and the current in both photodiodes linear. The ±10 V references for the second photodiode are duplicated on the un-isolated side with an inverting and non-inverting amplifier from two stages of U8, and with U2 a second +5 V precision voltage reference. These references connect across the un-isolated photodiode and a series output resistor that duplicates the feedback configuration on the isolated side. The 100 kΩ feedback resistor however is replaced by the series combination of fixed resistor R114 and potentiometer R115. This allows for the compensation of small current differences and current transfer ratios between the two photodiodes. C56, in combination with R114 and R115, is used to limit the high-frequency response of the isolator to under 800 Hz. The un-isolated photodiode output is buffered by a non-inverting amplifier with a gain of two consisting of op-amp U8, and resistors R120 and R119. This forms the final output stage of the isolation amplifier. The x2 gain is needed to

restore the signal to the original output level before the voltage division at the isolator's input. Resistors R116, R118 and potentiometer R117 provide an offset adjustment from the un-isolated ±10 V references for the output amplifier. The voltage at the wiper of the potentiometer is buffered by a unity gain non-inverting amplifier from the last op-amp of U8. The buffered offset adjustment connects to the output stage through resistor R119.

Low-Pass and Notch Filters

The output of the isolation amplifier connects to a series of filters. The first filter is a two-pole unity gain 90 Hz low-pass filter consisting of R129, R130, C63, C65, and an op-amp from U11. This filter is used to eliminate any high-frequency components generated by the opto-isolator circuitry. The output of the filter is attenuated by resistor divider R133 and R134 to accommodate the input range of U15, a switched capacitor notch filter. Using a standard 3.579545 MHz color burst oscillator crystal (X1), this filter can provide a selectable –40 dB notch at either 50 or 60 Hz by the simple grounding of one pin. The 50/60 Hz selection is done through Q4 which is controlled by circuitry on the FECG/UA Board. The supplies for U15 are generated from the ±15 V using two 3-terminal linear regulators VR2 and VR3. The output of U15 connects to another two-pole low-pass filter consisting of R136, R137, C71, C72, and an op-amp from U11. This is configured as a non-inverting unity gain filter with a –3 dB point of 56 Hz. The purpose of this low-pass filter is to remove any switching noise generated by the notch filter. The last stage is an inverting amplifier with a gain of three consisting of R142, R146, C73, and an op-amp from U11. This stage restores the signal level lost by the attenuator R133 and R134. Offsets introduced by U15 are also nulled out in this stage through the adjustable resistor network of R143, R145, R141, and potentiometer R144.

Table 4-25. FECG/UA Connector P5		
Pin Number	Signal Name	Signal Description
1	+15VISOL	+15 V Isolated Power Supply
2	–15VISOL	–15 V Isolated Power Supply
3	AGND	Analog Ground
4	PACEMAKER DET/	Pacemaker Detection Signal
5	LEADSOFF*	Leads Off Detection Signal
6	SEL1	MECG Lead Select Bit 1
7	SEL2	MECG Lead Select Bit 2
8	PACEMAKER ON	Pacemaker Enable Line
9	+15ISOL	+15 V Isolated Power Supply
10	–15VISOL	–15 V Isolated Power Supply
11	AGND	Analog Ground
12	No Connection	—
13	TEST PULSE	MECG Test Waveform
14	BOARD INSTALLED*	MECG Board Installed
15	No Connection	—
16	No Connection	—

Table 4-26. FECG/UA Board Connector P6		
Pin Number	Signal Name	Signal Description
1	MECG1	MECG Analog
2	+15V	+15 V Supply
3	–15V	–15 V Supply
4	AGND	Analog Ground
5	50/60HZ	MECG 50/60 Hz Filter Control Bit
6	+15V	+15 V Supply
7	–15V	–15 V Supply
8	AGND	Analog Ground

Table 4-27. MECG Patient Input Connector J7		
Pin Number	Signal Name	Signal Description
1	MECG SHIELD	Isolated Ground
2	MRL	Maternal Right Leg Drive
3	MLA	Maternal Left Arm Drive
4	MRA	Maternal Right Arm Drive

Oximeter Carrier Board

Optical isolators provide the RS-232C interface between the Front End Motherboard and the MSpO$_2$ Board. The Isolated Power Supply Board provides the ±15 V and +5 V signals.

$MSpO_2$ Board

Nellcor Module

Functional Overview

This internal module is manufactured by Nellcor Puritan Bennett, Inc. The module handles all circuitry involving $MSpO_2$ with the exception of the display circuitry. The module measures the maternal oxygen saturation and pulse rate using the principles of spectrophotometry and plethysmography. The $MSpO_2$ sensor is comprised of two light-emitting diodes (LEDs), which are the emitters, and one photodiode which is the detector. One LED emits red light and the other infrared into the patient's skin. The detector receives the amount of light that is not absorbed at the sensor site and the module uses the relative absorption of red and infrared to compute the percentage of functional hemoglobin that is saturated with oxygen.

The following technical information is a summary of the module's circuitry. This information is provided to give the hospital biomedical engineer an overall summary of the module's functions in relation to the host unit — to assist in isolating troubleshooting problems to the board level. This information is not intended to provide a complete circuit theory and should not be used to repair any problems on the module itself.

When a problem does exist with the module, contact your Corometrics Service Representative for information about repair/exchange of the module.

LED Driver Circuitry

This circuitry controls the on and off pulsing of the infrared and red LEDs at the measurement site. Signals REDLED/ and IRLED/ alternately close FET switches U4A and U4B, respectively. The LED drive voltages are developed by dual DAC U1. The LEDs operate in a four-phase sequence as follows:

- 184.5 µs: infrared LED on
- 184.5 µs: both LEDs off
- 184.5 µs: red LED on
- 184.5 µs: both LEDs off

Transistors Q1, Q2, Q3, Q4, Q5, and Q6 control the drive current switching. The four-phase LED drive signal is routed to LED driver U3A. The resulting drive potential is coupled equally to both sides of the bridge circuit via R31 to Q4 and R36 to Q3. Signals IRLED/ and REDLED/ are pulsed low to cause their respective LEDs to illuminate. When both lines are a logic high, all bridge transistors are turned off. The infrared LED is illuminated when signal IRLED/ is pulsed low. The red LED is illuminated when the signal REDLED/ is pulsed low.

Input Source Selection Circuits

The sensor is connected directly to the Nellcor module; the 120 Series Monitor does not provide an external pre-amplifier. Two inputs are handled by this circuitry. The SAT signal, developed by the photodiode in the sensor, enters through JP1 (pins 1 and 4). Pre-amplifier U8 is used as a current-to-voltage converter for the photodiode current. The signal is then coupled through U10A to the input amplifier and synchronous detector circuits. The wavelength of the red LED is derived from the

RCAL resistor in the sensor which connects between pin 6 of JP1 and ground to become part of a voltage divider with R16. Power for this divider is a 2.5 V reference on the Nellcor module. This calibration voltage (VCAL2) is communicated to the DAC via buffer U21B.

Input Amplifier and Synchronous Detector

The SAT signal is conditioned by the input amplifier and the synchronous detector to provide signal gain and reduce or eliminate the effects of ambient interference. Negative peak detector U7 is employed to monitor the SAT signal while it is still DC-coupled; it produces a DC output proportional to the maximum negative excursion of the SAT signal pulses. If the negative excursions of the SAT signal exceed –10 V, the modules's microprocessor, that is monitoring the output of U7A (COMPARE1), initiates action to reduce the output of the dual DAC that controls LED intensity. The microprocessor may reduce current through only one of the LEDs if necessary.

The SAT signal is then coupled through C55 to remove the DC offset or steady-state ambient energy artifact. The signal is then coupled to band-pass filter U13B to remove noise. The output of U13B is then introduced to a programmable gain circuit consisting of DAC U9 and operational amplifier U13A.

The signal is then coupled to full-gain amplifier U14B. The output of U14B is used by the modules's microprocessor as the sense point to determine input channel gain requirements. Positive peak detector U7B is employed to monitor the amplified SAT signal at the output of U14B. It produces a DC output (COMPARE2) proportional to the positive excursion of the amplified SAT signal pulses. If (COMPARE2) exceeds +10 V, the modules's microprocessor reduces U13A gain. The microprocessor may also reduce LED drive for one LED if necessary.

The SAT signal is finally coupled to the synchronous detector comprised of U10B, U14A, and associated resistors. When the positive input of U14A is grounded by U10B, the device is an inverting amplifier with a gain of one. When this input is not grounded, the device becomes a voltage follower with a gain of one. The output of the synchronous detector is applied to the filter/amplifier circuitry.

Filters/Amplifiers

The module includes two separate active filter channels: infrared and red. These low-pass filter/amplifier circuits and associated gating circuits recover the patient's pulse waveform from the multiplexed SAT signal. FET switches U15A and U15B are employed to separate the infrared information in the SAT signal from the red information. The gate control input signals (IRGATE/ and REDGATE/) are processor-controlled and operate in time sequence with the four-phase LED drive control. This switching action is used to control the inputs to the red and infrared filter / amplifier circuits.

The infrared filter/amplifier circuit is an active low-pass filter (total gain = 4) which responds to the patient's pulse modulation — reproducing the patient's pulse waveform at the filter/amplifier output. The infrared pulses (IR) are coupled to the first of two identical filter/amplifier stages (U22D and U22B), each having a gain of approximately two. The signal is then coupled to the last stage (U23B) which has a gain of one. The pulse waveform (IR) at the output of the filter/amplifier stages, must always be at a positive voltage level in order to be digitized by the analog-to-digital conversion circuitry. The final amplifier stage has an input offset of +25 mV to ensure that the waveform does not move to a negative level. The output (IR ADC) is then coupled to the analog-to-digital conversion section.

The red filter/amplifier circuit is an active low-pass filter (total gain = 8) which responds to the patient's pulse modulation — reproducing the patient's pulse waveform at the filter/amplifier output. The red pulses (RED) are coupled to the first of two identical filter/amplifier stages (U22A and U22C), each having a gain of approximately two. The signal is then coupled to the last stage (U23A) which also has a gain of two. The pulse waveform (RED) at the output of the filter/amplifier stages, must always be at a positive voltage level in order to be digitized by the analog-to-digital conversion circuitry. The final amplifier stage has an input of +25 mV to ensure that the waveform does not move to a negative level. The output (RED ADC) is then coupled to the analog-to-digital conversion section.

Analog-to-Digital Conversion Circuitry

The analog-to-digital (A/D) conversion block digitizes the infrared and red pulse waveforms. Sensor calibration information is also digitized for use in the saturation calculation algorithms. A/D converter U20 is a dual-channel device which produces a multiplexed serial output. Channel 1 (AIN1) accommodates either VCAL1 voltage or the analog pulse waveform (RED ADC) from the red filter/amplifier channel. Channel 2 (AIN2) accommodates either VCAL2 voltage or the analog pulse waveform (IR ADC) from the infrared filter/amplifier channel. These selections are determined by the configuration of quad FET switch U24. Switching is controlled by the signal RESISTORS. The output bit serial stream multiplexing of U20 is determined by logic signal ADCCHN, which determines the channel present on the ADCDATA line. The ADCDATA line is coupled directly to microprocessor U5 for saturation value and pulse rate calculation prior to being routed to the 120 Series Monitor display processing circuitry.

Communications

Four data signals are used to communicate between the Nellcor module and the SpO_2 Interface Board in the Oximeter Carrier Board in the 120 Series Monitor: CTS, RESET, RXD, and TXD.

Processor Circuitry

The module support circuitry consists of microprocessor U5, ROM U6, and RAM U12, all served by latch U2. Serial-to-parallel shift register U16 converts serial data to parallel data for the DACBUS. The system operates using an 11 MHz crystal-controlled oscillator. Sections U11 and U17 perform reset and buffer functions for the communications link.

Masimo Module

Principle of Operation

The Masimo SET® MS-5 pulse oximeter is based on three principles:

1. Oxyhemoglobin and deoxyhemoglobin differ in their absorption of red and infrared light (spectrophotometry).
2. The volume of arterial blood in tissue and the light absorbed by the blood changes during the pulse (plethysmography).
3. Arterio-venous shunting is highly variable and that fluctuating absorbance by venous blood is a major component of noise during the pulse.

The Masimo SET MS-5 pulse oximeter as well as traditional pulse oximetry determines SpO2 by passing red and infrared light into a capillary bed and measuring changes in light absorption during the pulsatile cycle. Red and infrared light-emitting diodes (LEDs) in oximetry sensors serve as the light sources, a photodiode serves as the photodetector.

Traditional pulse oximetry assumes that all pulsations in the light absorbance signal are caused by oscillations in the arterial blood volume. This assumes that the blood flow in the region of the sensor passes entirely through the capillary bed rather than through any arterio-venous shunts. The traditional pulse oximeter calculates the ratio of pulsatile absorbance (AC) to the mean absorbance (DC) at each of two wavelengths, 660 nm and 940 nm:

S(660) = AC(660)/DC(660)

S(940) = AC(940)/DC(940)

The oximeter then calculates the ratio of these two arterial pulse-added absorbance signals:

R = S(660)/S(940)

This value of R is used to find the saturation SpO2 in a look-up table built into the oximeter's software. The values in the look-up table are based upon human blood studies against a laboratory co-oximeter on healthy adult volunteers in induced hypoxia studies.

The Masimo SET MS-5 pulse oximeter assumes that arterio-venous shunting is highly variable and that fluctuating absorbance by venous blood is the major component of noise during the pulse. MS-5 decomposes S(660) and S(940) into an arterial signal plus a noise component and calculates the ratio of the arterial signals without the noise:

S(660) = S1 + N1

S(940) = S2 + N2

R = S1/S2

Again, R is the ratio of two arterial pulse-added absorbance signals and its value is used to find the saturation SpO2 in an empirically derived equation into the oximeter's software. The values in the empirically derived equation are based upon human blood studies against a laboratory co-oximeter on healthy adult volunteers in induced hypoxia studies.

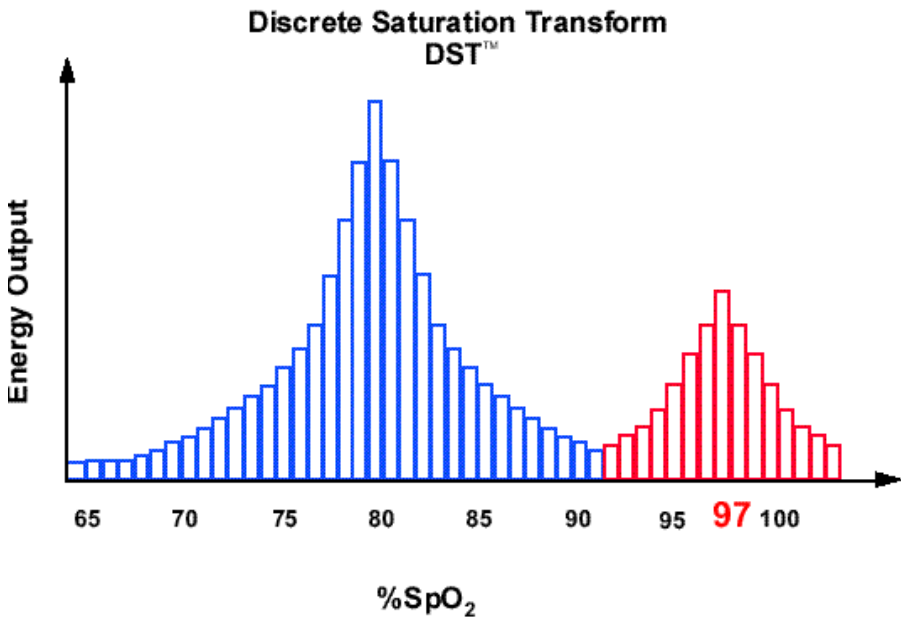
The above equations are combined and a noise reference (N') is determined:

N' = S(660) - S(940) x R

If there is no noise N' = 0: then S(660) = S(940) x R which is the same relationship for the traditional pulse oximeter.

The equation for the noise reference is based on the value of R, the value being sought to determine the SpO2. The MS-5 software sweeps through possible values of R that correspond to SpO2 values between 1% and 100% and generates an N' value for each of these R values. The S(660) and S(940) signals are processed with each possible N' noise reference through an adaptive correlation canceler (ACC) which yields an output power for each possible value of R (i.e., each possible SpO2 from 1% to 100%). The result is a Discrete Saturation Transform (DST™) plot of

relative output power versus possible SpO2 value as shown in the following figure where R corresponds to SpO2 = 97%:



The DST plot has two peaks: the peak corresponding to the higher saturation is selected as the SpO2 value. This entire sequence is repeated once every two seconds on the most recent four seconds of raw data. The MS-5 SpO2 therefore corresponds to a running average of arterial hemoglobin saturation that is updated every two seconds.

Isolated Power Supply Board

NOTE: A newer, surface-mount board replaces earlier versions. Functionally, the boards are equivalent. Refer to "Chapter 14, Replacement Parts" for further information.

Controller

The isolated fly-back converter is based around the LT1270 (U4) high-efficiency switching regulator. This regulator has a high-current, high-efficiency switch included on its die along with all oscillator, control, and protection circuitry. The LT1270 is a current mode switcher. This means that the switch duty cycle is directly controlled by switch current rather than output voltage. The switcher was designed to operate in the discontinuous mode with a duty cycle less than 50 %.

C5 is the input capacitor for the switcher. The input capacitor is essential for the proper operation of the circuit. It absorbs the ripple current inherent in a fly-back converter's input.

The Vc pin of U4 is used for frequency compensation, soft start and external synchronization. It is the output of an error amplifier and the input of a current comparator. The maximum source and sink current is approximately 220 µA. The voltage on the Vc pin determines the current level at which the output switch will turn off. For Vc voltages below 0.9 volts, the output switch will be totally off (duty cycle = 0). Above 0.9 volts, the switch will turn on at each oscillator cycle, then tun off when the switch current reaches a trip level set by the Vc voltage. The control loop frequency compensation is performed by R2 and C6.

The VFB (feedback) pin of U4 is the inverting input to a single stage error amplifier. The non-inverting input to this amplifier is internally tied to a 1.244 volt reference. The amplifier is a gm type, meaning that it has high output impedance with controlled voltage-to-current gain. DC voltage gain with no load is approximately 800. The signal sent to this pin is derived from the isolated +15VISO using a linear optocoupler (see section 3.4 Isolated Feedback).

The Vsw pin of the LT1270 is the collector of the internal NPN power switch. This NPN has a typical ON resistance of 0.12 W and a breakdown voltage (BVCBO) of 60 volts.

The transformer T1 is not an is not an ideal component, so not all the energy stored in the core is transferred to the secondary winding. The energy left in the primary winding leakage inductance causes a spike on the leading edge of the switch node voltage. Components D4, D5, R3, and C7 are used to clamp the switch node voltage, providing a current path for the leakage inductance spike. R3 and C7 also are used to reduce the radiated EMI created by the fast switching of large current signals. When the internal switch of the LT1270 opens, the voltage at the Vsw pin jumps up to approximately 30 V. R3 and C7 smooth the rising edge of this pulse thereby reducing any high frequency ringing.

External Synchronization

The external synchronization of the LT1270 (U4) occurs when its Vc pin is pulled to ground with an external transistor. To avoid disturbing the DC characteristics of the internal error amplifier, the width of the synchronizing pulse must be under 1 µs. The circuitry for synchronizing is comprised of Q1, D1-3, C2, C3, R1, R24-26, and U5.

The external synchronizing clock (72 kHz) is connected to an input of a two input AND gate (U5). The other input is connected to a reset signal (RESET*). The reason for the reset signal is because upon start up the controller (U4) must be allowed to first free-run before it can be externally synchronizing. Holding the reset line low will inhibit synchronizing. Resistors R28 and R29 are to prevent U5 pins 12 and 13 from floating during board testing. The remaining three AND gates from U5 are paralleled, each with a 47 W output resistor, to provide as much drive current as possible into the synchronizing circuitry. U5 is powered from VR1, a linear +5 Vdc regulator.

C3 and R1 differentiate the 72 kHz clock. On positive going edges of the clock a narrow positive pulse is applied to the base of transistor Q1. The values of C3 and R1 determine the width of this pulse. D1 and D2 block the negative portion of the differentiated signal. D3 speeds up the turn off time of Q1.

Fly-back Transformer, Output Rectification, and Filtering

The fly-back transformer (T1) was constructed to meet the creepage requirements of I.E.C. 601-1. Its breakdown voltage is 3000 VAC (1 minute, primary to secondary). The primary inductance is 30 µH (at 1 kHz). At the supplies maximum load, the peak primary current is approximately 5.9 A.

The output rectifiers are D7–9. They are silicon ultra-fast switching rectifiers with a maximum peak reverse voltage of 100 V. The main ±15 V outputs (+15VISO, –15VISO) and the secondary ±15 V outputs (+15VISO2, –15VISO2) each use one 220 µF aluminum electrolytic capacitors for their main filtering (C22, 23,11,12). One 220 µF capacitor connected has an equivalent ESR of 0.12 W at 72 kHz. Each output utilizes a linear regulators (VR2, 3,5,6,7) to obtain their outputs. C15,16,30,32,34 provide the necessary output filtering for the linear regulators. The regulators (LM2940CT-15, LM2990T-15) have internal short circuit and thermal protection. Short circuit protection for the total supply is provided by the in-rush current limiter. See “Short Circuit Protection” on page 4-79.

Because the linear regulators for the +15VISO, –15VISO outputs are not located close to the filter capacitors, C29 and C30 were used to prevent any instability in these regulators.

The +15VISO2 and –15VISO2 outputs have load resistors on the supply (R18,19). These resistors keep the unregulated outputs of this lightly loaded supply from getting too high. The filter capacitors are rated for 25 Vdc. Without the load resistors, the unregulated voltage could exceed this rating.

For further EMI reduction, RC series networks (R16, C27, R17, C26) are placed across each secondary output. Resistors R18–21 are used to guarantee a minimum load for each output. Both isolated grounds (ISOGND and ISOGND2) are meant to be isolated from each other. To keep them isolated, yet at approximately the same

potential, the parallel combination of C24 and R27 was connected across the two grounds.

Isolated Feedback

The feedback for the supply crosses the isolation barrier via a linear optocoupler (U2). The complete feedback circuit is comprised of U1–3, VR4, R7–13, C10,19,20,21,25.

The IL300 linear optocoupler consists of an AIGAs IRLED irradiating an isolated feedback and an output PIN photodiode in a bifurcated arrangement. The feedback photodiode captures a percentage of the LED's flux and generates a control signal that can be used to servo the LED drive current. This technique compensates for the LED's non-linear, time, and temperature characteristics. The output PIN photodiode produces an output signal that is linearly related to the servo optical flux created by the LED.

As stated in "Controller", the VFB pin of U4 wants to be at 1.244 V to close the loop. R10 and R11 divides down the main +15 V unregulated output to 1.245 V. U1 and R9 source current into the IRLED. R12 and the internal PIN photodiode of U2 close the loop around U1. C21 provides some high frequency roll-off for amplifier U1.

VR4 and C19 provide a steady +5 Vdc supply that is used by the isolated PIN photodiode of the linear optocoupler and powers operational amplifier U1.

On the non-isolated side, R7, R13, and the current being sourced from the second PIN photodiode, re-create the feedback voltage seen on the isolated side at U1–3. The IL300s are bin sorted by the manufacturer to group the parts with common transfer gains. The transfer gain of the IL300 can vary from 0.56 to 1.61. Instead of paying a premium for buying only one bin, a potentiometer (R7) was used so that the variations in the transfer gains of U2 could be corrected for. If the IL300's gain was 1.0, the combined resistance of R7 and R13 would equal that of R12. C25 provides some filtering for the feedback signal. U3 and R8 provide buffering between the feedback signal and the VFB pin of U4.

Short Circuit Protection

Short circuit protection for the entire supply is provided by R14, R30 and Q2. When the voltage at the Vc pin of U4 reaches approximately 1.33 V, Q2 will start conducting current from its emitter to collector which limits the amount of power the supply can deliver. During a short on any output, the Vc pin wants to increase so that the duty cycle of the supply can increase and supply more power to the load. This circuit limits the maximum power the supply can deliver to any load to approximately 10 W.

This circuit also helps reduce the peak in-rush current this type of supply sees during its power-up sequence. As with the short circuit protection mentioned above, this circuit limits the amount of current the supply can "dump" into the output filter capacitors during power-up thus reducing the overall in-rush current.

Input Filter/Isolation Barrier

An LC filter (C1,L3) is placed between the +20VDC input supply and the +20I voltage that powers the switching supply. This filter prevents noise from the switching supply from getting out on the +20VDC supply bus. This reduces the radiated RF produced from the switching supply.

A spark gap (SG1) bridges the isolation barrier and is connected with two 10 kΩ resistors (R22, R23) that connect to each ground. This circuit provides a high-voltage path from the isolation ground to the earth ground. This guarantees that if the isolated ground sees a high voltage (i.e. defibrillator pulse) the current will go through the spark gap instead of breaking down the linear optocoupler or the fly-back transformer. The optocoupler and the transformer have breakdown voltage ratings higher than that of the spark gap.

Table 4-28. Power Connector J1		
Pin Number	Signal Name	Signal Description
1	GNDI	Power Ground (earth)
2	GNDI	Power Ground (earth)
3	GNDI	Power Ground (earth)
4	GNDI	Power Ground (earth)
5	GNDI	Power Ground (earth)
6	GNDI	Power Ground (earth)
7	GNDI	Power Ground (earth)
8	GNDI	Power Ground (earth)
9	GNDI	Power Ground (earth)
10	GNDI	Power Ground (earth)
11	GNDI	Power Ground (earth)
12	GNDI	Power Ground (earth)
13	GNDI	Power Ground (earth)
14	GNDI	Power Ground (earth)
15	GNDI	Power Ground (earth)
16	GNDI	Power Ground (earth)
17	GNDI	Power Ground (earth)
18	GNDI	Power Ground (earth)
19	GNDI	Power Ground (earth)
20	GNDI	Power Ground (earth)
21	RESET*	Sync Clock Disable
22	72KHZ	72 kHz Sync Clock
23	GNDI	Power Ground (earth)
24	GNDI	Power Ground (earth)
25	+20VDC	+20 Vdc Input Voltage
26	+20VDC	+20 Vdc Input Voltage

Table 4-29. Power Connector J2		
Pin Number	Signal Name	Signal Description
1	+15VISO2	Isolated +15 Vdc (2)
2	+15VISO2	Isolated +15 Vdc (2)
3	ISOGND2	Return for Outputs (2)
4	ISOGND2	Return for Outputs (2)
5	–15VISO2	Isolated –15 Vdc (2)
6	–15VISO2	Isolated –15 Vdc (2)
7	No Connection	—
8	No Connection	—
9	+15VISO	Isolated +15 Vdc (1)
10	+15VISO	Isolated +15 Vdc (1)
11	ISOGND	Return for Outputs (1)
12	ISOGND	Return for Outputs (1)
13	–15VISO	Isolated –15 Vdc (1)
14	–15VISO	Isolated –15Vdc (1)
15	No Connection	—
16	+15MSPO2	$MSpO_2$ +15 Vdc
17	No Connection	—
18	GNDMSPO2	Return for Maternal SpO_2 ±15 Vdc
19	No Connection	—
20	–15MSPO2	$MSpO_2$ –15 Vdc
21	No Connection	—
22	No Connection	—
23	GNDISOL	Return for Isolated +5 Vdc
24	+5ISOL	Isolated +5 Vdc
25	GNDISOL	Return for Isolated +5 Vdc
26	+5VISOL	Isolated +5 Vdc

Recorder Board

NOTE: A newer, surface-mount board replaces earlier versions. Functionally, the boards are equivalent. Refer to "Chapter 14, Replacement Parts" for further information.

The recorder board provides the interface between the Main Motherboard and the strip chart recorder. The board performs three functions. First it powers the recorder head through an adjustable regulator. Second it drives the 4-phase stepper motor, and third it provides the paper-out, paper-low, and paper-misloaded interface circuitry.

The monitor's power supply module provides a regulated 20 Vdc which enters the Recorder Board at J1 (pins 9, 10) and powers the input to a voltage regulator (VR1). Voltage regulator VR1 is adjustable and provides a regulated DC output from 13 V to 18 V depending on the position of the wiper on potentiometer R2. This output powers the heating elements in the thermal printhead. Since printheads very in average resistance, this voltage is calibrated to the value required by the particular printhead installed.

A variety of safeguards shut down the printhead heating element supply (VHD) under various conditions to protect the printhead. When the 5 V supply to the logic circuitry is low, diode D1 will not be forward biased and transistor Q3 will be off. Transistor Q1 will then saturate and bring pin 3 of VR1 to ground. The output of VR1 will then be approximately 1.3 V. also, when transistor Q2 is turned on, the current through resistor R4 to the base of Q1 will turn on Q1 and shut the output of VR1 sown to 1.3 V. The first condition that can turn on transistor Q2 is when the RE/ logic signal is low. This occurs during power-up reset of the microprocessor or when the microprocessor brings HDSHUT/ low by writing to the appropriate output port. The microprocessor brings HDSHUT/ low immediately after it comes out of reset and brings it high before printing. Another condition than can turn on Q2 is when POUT/ is low.

Table 4-30. Power Input Connector J1		
Pin Number	Signal Name	Signal Description
1	+5VM	–5 Volt Supply for Motor
2	+5VM	–5 Volt Supply for Motor
3	GNDM	Motor Ground
4	GNDM	Motor Ground
5	GNDH	Ground for Head Regulator
6	GNDH	Ground for Head Regulator
7	GNDVR	Ground for Logic
8	+5VR	+5 Volt Supply for Logic
9	+22VH	22 Volt Supply for Head Regulator
10	+22VH	22 Volt Supply for Head Regulator

Table 4-31. Head Output Connector J4		
Pin Number	Signal Name	Signal Description
1	VH	+V Head Supply Voltage (15.5 V nominal)
2	VH	+V Head Supply Voltage (15.5 V nominal)
3	GNDH	VHEAD Supply Ground Return
4	GNDH	VHEAD Supply Ground Return
5	STRB4/	Strobe Line for 4th Set of 256 Dots
6	STRB3/	Strobe Line for 3rd Set of 256 Dots
7	GNDVR	Logic Ground
8	+5VR	+5 V for Logic
9	No Connection	—
10	No Connection	—
11	STRB2/	Strobe Line for 2nd Set of 256 Dots
12	STRB1/	Strobe line for 1st set of 256 dots
13	CK	Ground
14	LDD/	Recorder Load Line
15	BEOB	Head Data Enable Line (Active High)
16	DATA	Recorder Data Line
17	GNDH	VHEAD Supply Ground Return
18	GNDH	VHEAD Supply Ground Return
19	VH	+V Head Supply Voltage (15.5 V nominal)
20	VH	+V Head Supply Voltage (15.5 V nominal)

Table 4-32. Stepper Motor Connector J4		
Pin Number	Signal Name	Signal Description
1	No Connection	KEY (cut pin)
2	PC	Motor Phase 3
3	PD	Motor Phase 4
4	VM	+5 V
5	No Connection	—
6	PB	Motor Phase 2
7	PA	Motor Phase 1
8	VM	+5 V

Table 4-33. Paper Low Sensor Connector J5		
Pin Number	Signal Name	Signal Description
1	OPTOA	LED+
2	GNDVR	LED–
3	GNDVR	Emitter
4	OUTPUT	Collector

Table 4-34. Paper Out Sensor Connector J6		
Pin Number	Signal Name	Signal Description
1	OPTOA	LED+
2	GNDVR	LED–
3	GNDVR	Emitter
4	OUTPUT	Collector

Table 4-35. Paper Tray Sensor Connector J8		
Pin Number	Signal Name	Signal Description
1	No Connection	Key
2	PLOAD	Collector of Sensor
3	LED	LED of Sensor
4	GND	Ground

Table 4-36. Test Connector J9		
Pin Number	Signal Name	Signal Description
1	VH	Head Supply Voltage
2	HGND	Head Supply Ground
3	POUT	Paper Out Test Point
4	PLOW	Paper Low Test Point
5	DGND	Digital Ground
6	PLOAD	Paper Tray Sensor Test Point

Chapter 5

Setup Procedures

This section describes the routine setup procedures for the 120 Series Monitor, as well as information about tailoring the monitor to meet the individual needs of the hospital.

This section contains the following information:

Loading Strip Chart Recorder Paper 5-2
Mounting a Strain Gauge for IUP Monitoring 5-5
User Setup Screens 5-6
FSpO2 Setup Screen 5-19
Service Mode Screens 5-25
Hardware Switches 5-34

Loading Strip Chart Recorder Paper

CAUTIONS

LOADING PAPER—The instructions for loading paper into the 120 Series Monitor *are different* than the instructions for loading paper into other Corometrics monitors. Improper loading can cause paper jams. Follow the instructions carefully.

PAPER TYPE—Do not use *non*-Corometrics paper or paper designed for use with *other* Corometrics monitors. Using the wrong paper may produce inferior print quality; could result in permanent damage to the recorder's print head; and may void your warranty. Refer to "Chapter 14, Replacement Parts" for parts information.

STORAGE/TRANSPORT—Paper should be installed in the monitor's strip chart recorder at *all* times. This reduces particle build-up on the printhead and facilitates opening the recorder door.

To protect against paper jams, the 120 Series recorder contains a paper-loading sensor which detects if the paper has been incorrectly loaded. When the recorder detects a paper-load–error condition:

- the recorder will not print;
- the **Record** indicator flashes on and off every second;
- three short chimes sound every three seconds at a fixed volume of 6; and the message **PAPER INCORRECTLY LOADED, RELOAD WITH BLACK SQUARES DOWN** is displayed overlaying any waveform in the maternal waveform area.

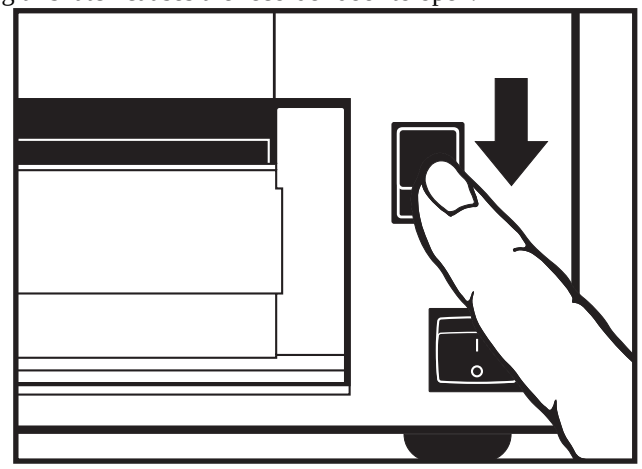
You may temporarily silence a paper-load–error condition by pressing the **Alarm Silence** pushbutton. The audio alarm will be re-issued if the paper-load–error condition continues after the specified silence period (re-alarm time). The re-alarm time is adjustable from the Master Alarm Setup screen. Refer to page 5-18 in this section.

The 120 Series Monitor also alerts you when paper is running low and when the recorder is completely out of paper.

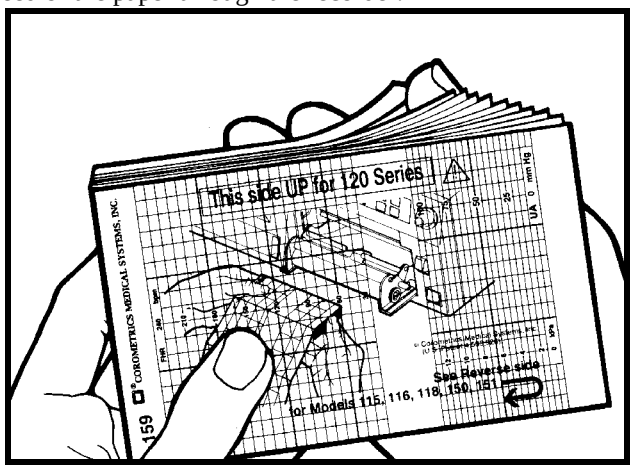
To install Corometrics strip chart paper in the 120 Series Monitor, follow these steps:

CAUTION
LOADING PAPER—Paper loading instructions for the 120 Series Monitor *are different* than other Corometrics Monitors. Improper loading can cause paper jams. Follow the instructions carefully.

1. Press down on the latch on the right side of the strip chart recorder door. Pressing this latch causes the recorder door to open.



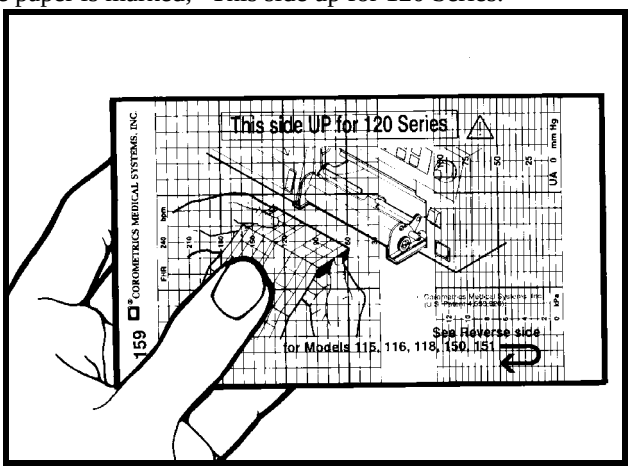
2. Fan the pack of Z-fold paper on all sides to loosen any folds and to ensure proper feed of the paper through the recorder.



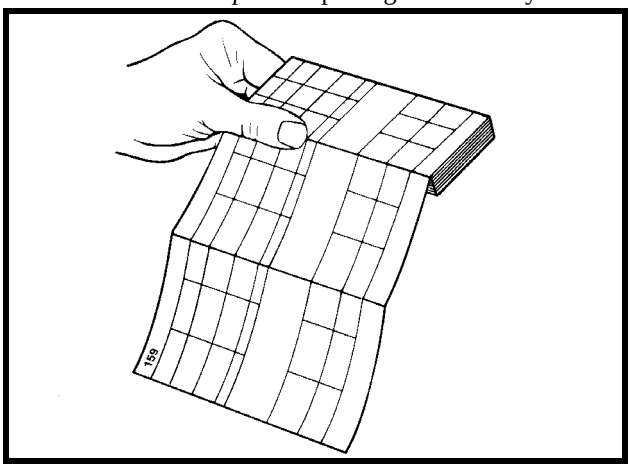
3. Hold the package of paper so that:
   - **the black squares are on the *bottom* of the pack**; and
   - the Corometrics logo and page numbers are on the *left* side of the pack.

NOTE: The black squares indicate the end of the recorder paper. When the black squares appear, the strip chart recorder has approximately 20 minutes of paper remaining, when running at a speed of 3 cm/min.

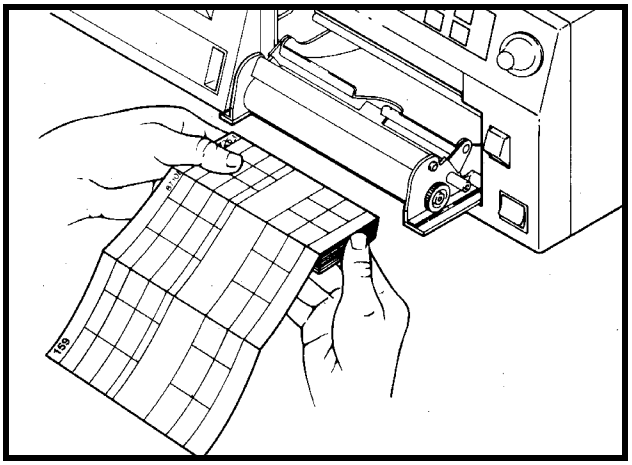
NOTE: The paper is marked, "This side up for 120 Series."



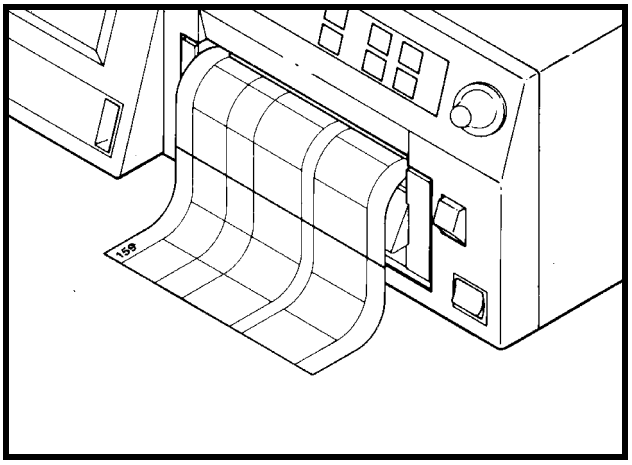
4. Unfold two sheets from the *top* of the package so that they extend toward you.



5. Place the pack in the drawer so that the pack is laying flat in the recorder.



6. Slowly close the strip chart recorder door, being careful not to skew the paper.



Mounting a Strain Gauge for IUP Monitoring

To mount a strain gauge post, refer to the manufacturer's directions.

User Setup Screens

The 120 Series Monitor provides a variety of options that are all selected using setup screens shown on the display. (The illustrations in this section are representative of all possible features. Your monitor screens may vary.) All functions are performed easily using the front panel Trim Knob control. The following setup screens are selectable from the display:

- FECG
- US
- US2
- Maternal NBP
- $MSpO_2$
- $FSpO_2$
- MHR/P
- Master Alarm
- General

Refer to for Factory Default information.

Using the Trim Knob Control

General instructions for using the Trim Knob control follow:

1. To display a parameter setup screen, rotate the Trim Knob control until the bar cursor highlights the title of the parameter (FECG, US, US2, NBP, $MSpO_2$, $FSpO_2$, MECG, or PULSE). To access the Master Alarm Setup screen or the General Setup screen, rotate the Trim Knob control until the bar cursor highlights the **ALARMS** softkey or the **SETUP** softkey, respectively, on the bottom of the screen.
2. Press the Trim Knob control once to display the selected setup screen.
3. While the screen is displayed, rotate the Trim Knob control until the desired field is highlighted.
4. Press the Trim Knob control once to activate the selected field. The cursor now flashes.
5. Rotate the Trim Knob control in either direction to cycle through the available choices for the field. Continuous rotation will wrap around through the choices.
6. When the desired selection is made for the field, press the Trim Knob control once to enact the selection.
7. Repeat steps three (3) through six (6) until all desired settings have been made.
8. Rotate the Trim Knob control until the bar cursor highlights the **EXIT** softkey on the bottom of the screen. Press the Trim Knob control and the monitor returns to normal operation.

IMPORTANT

EFFECTIVITY—All changes take effect immediately after a selection is enacted in step six (6).

NOTE: While any setup screen is displayed, the primary labor parameters remain displayed. While using a setup screen, if an alarm condition exists for a maternal parameter that is not displayed, only an audio alarm (if enabled) is issued. Upon exiting the setup screen, the visual alarm indication is shown.

Example. If the NBP Setup screen is displayed, the primary labor parameters continue to be displayed as well as the maternal NBP area of the screen. Under an alarm condition that affects NBP, both a visual and audible (if enabled) alarm will be issued. Under an alarm condition that affects $MSpO_2$ or MECG, only an audio alarm (if enabled) is given while the NBP Setup screen remains displayed; once the setup screen is exited, the visual alarm indication for $MSpO_2$ or MECG will be shown.

FECG Setup Screen

Select the FECG softkey to access the FECG Setup screen (Figure 5-1). For information on settings, refer to Appendix A, “Factory Defaults” .

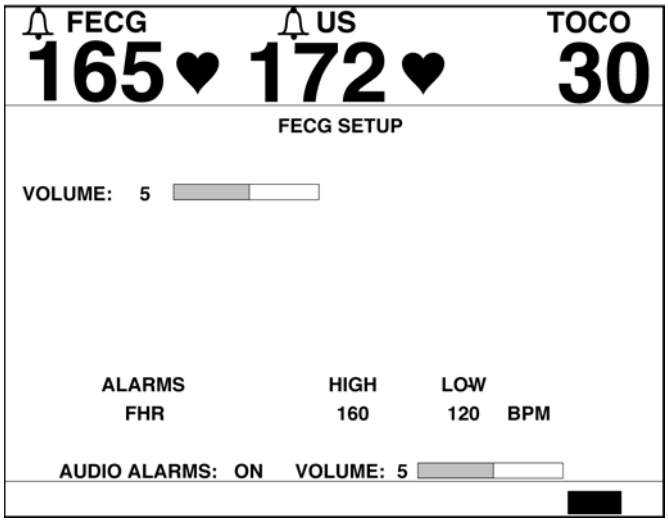


Figure 5-1. FECG Setup Screen

Volume

This field controls the volume for the FHR derived from FECG. This works in conjunction with the four front panel **Volume** pushbuttons.

FHR Alarm Limits

These fields adjust the high and low alarm limits for FHR.

NOTE: The FHR1 and FHR2 alarm limits are set independently of each other.

FHR Audio Alarm

This field enables/disables the audio alarm function for FHR when derived from FECG.

- **On:** Visual and audible indications are provided during an FHR alarm condition.
- **Off:** Only a visual indication is provided during an FHR alarm condition.

Alarm Volume

This field controls the alarm volume for *FECG* alarms.

US/US2 Setup Screen

Select the US or US2 softkey to access the US/US2 Setup screen (Figure 5-2). The title of the screen (US vs. US2) is dependent on the mode selected when the screen is activated. For information on settings, refer to Appendix A, “Factory Defaults” .

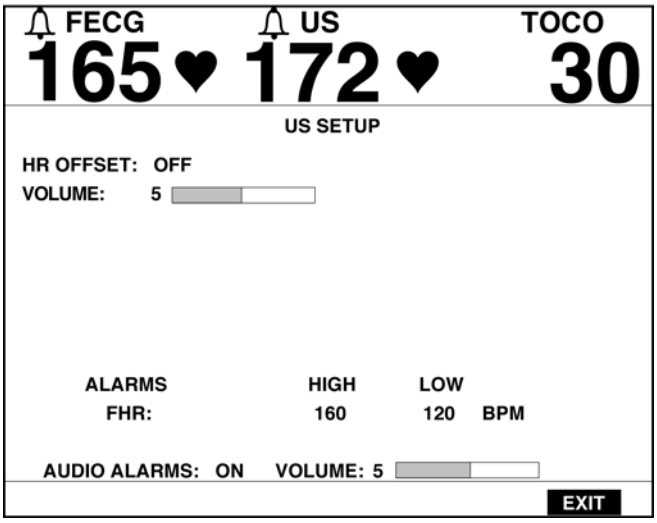


Figure 5-2. US/US2 Setup Screen

Fetal Movement Detection

This field is only displayed: for the US connector; *and* if the option is installed in your monitor; *and* if a transducer is plugged into the US connector.

Fetal Heart Rate Offset

This field is used to shift the secondary FHR trend +20 BPM to facilitate viewing overlapping trends. This field provides an alternative to using the front panel Mark (Offset) button.

- **On*:** Shifts the secondary FHR trend +20 BPM.
- **10 Min:** Shifts the secondary FHR trend +20 BPM. After 10 minutes, the trend automatically returns to the unshifted position.
- **Off:** Returns the secondary FHR trend to the unshifted position.

The FHR Offset field is only present on the setup screen when:

- the heart rate offset option is enabled via the Install Options service screen; *and*
- the screen is activated by selecting the mode listed in the FHR2 area of the display.

* *This field selects between either on/off or 10 Min/Off, depending on how this feature is enabled on the Install Options service screen.*

Volume

This field adjusts the volume for the FHR derived from the selected mode, US or US2. This field works in conjunction with the front panel Volume buttons.

FHR Audio Alarm

This field enables/disables the audio alarm function for FHR when derived from US/US2.

- **On:** Visual and audible indications are provided during an FHR alarm condition.
- **Off:** Only a visual indication is provided during an FHR alarm condition.

Alarm Volume

This field controls the alarm volume for *Ultrasound* alarms.

Maternal NBP Setup Screen

Select the NBP softkey to display the NBP Setup screen (Figure 5-3). For information on settings, refer to Appendix A, “Factory Defaults” .

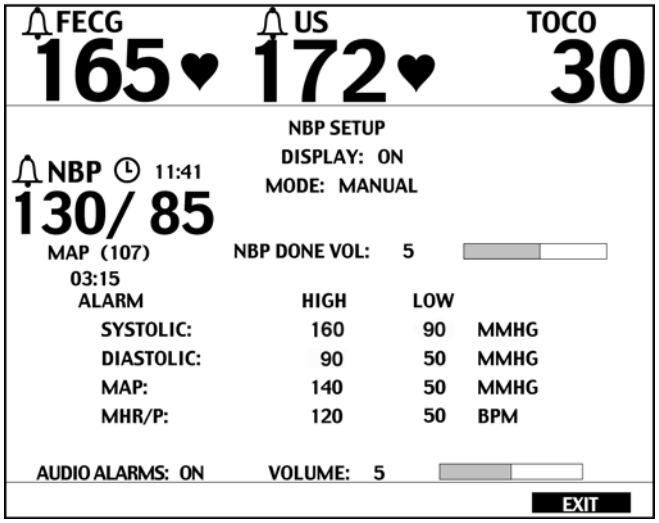


Figure 5-3. Maternal NBP Setup Screen

Display Timer

This field determines the time period, in minutes, that a blood pressure reading remains displayed before being automatically erased, starting from the time the reading is displayed.

NOTE: Values are removed from the NBP area of the display only; values are still retained in memory for display and printing of the maternal Vital Signs History screen.

This feature reduces the chance of error. For example: if the monitor is configured for manual mode and one hour has elapsed since the last reading, the continuous display of the “old” NBP reading may cause confusion.

Mode

This field alternates between the manual and automatic monitoring modes for maternal blood pressure. For auto mode, this field also sets the interval time, in minutes, between automatic blood pressure determinations. This interval time is measured from beginning to beginning of determinations. (Refer to the 120 Series Operator’s Manual for exceptions to this rule.)

The monitor is factory-set with the optional 1-minute interval time disabled. Refer to “NBP One-Minute Interval” on page 5-28 for information on enabling the 1-minute interval.

NOTE: As soon as the auto mode is selected on the setup screen, the countdown timer begins to decrement. *The first automatic determination begins after expiration of one complete interval time period.*

NBP Done Volume

This field sets the volume of the sound emitted at the completion of each blood pressure determination. As you adjust the volume, a sample tone sounds.

Alarm Limits

These fields adjust the high and low alarm limits for maternal systolic, diastolic, and mean arterial pressures, as well as for MHR/P—in increments of 5 mmHg or 5 BPM.

Audio Alarm

This field enables/disables the audio alarm function for blood pressure.

- **On:** Visual and audible indications are provided during an alarm condition.
- **Off:** Only a visual indication is provided during an alarm condition.

Master Alarm Volume

This field controls the alarm volume for *all* alarms.

MSpO$_2$ Setup Screen

Select the MSPO2 softkey to display the MSpO$_2$ Setup screen (Figure 5-4). For settings information, refer to Appendix A, “Factory Defaults” .

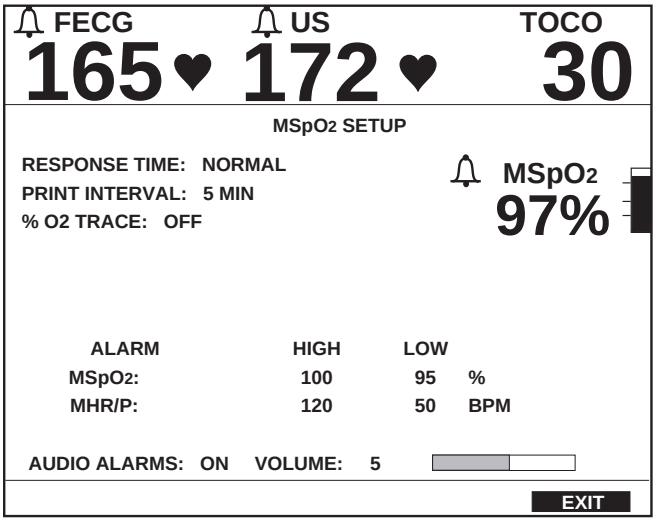


Figure 5-4. Nellcor MSpO$_2$ Setup Screen

NOTE: If you are using Masimo (instead of Nellcor) technology, the **Response Time** setting will be missing on your Setup Screen. In its place, a setting for **Averaging Time** and **Sensitivity** will display.

Response Time (Nellcor Module Only)

Choose a response time modes in order to compensate for different levels of patient activity.

- **Slow:** Uses a 10- to 15-second averaging period and is least affected by patient movement. When this setting is selected, dashes “– – –” replace the pulse value displayed in the MHR/P area.
- **Normal:** Uses a 5- to 7-second averaging period and is recommended in cases where the patient is relatively inactive.
- **Fast:** Uses a 2- to 3-second averaging period and is most affected by patient movement.

Sensitivity (Masimo Module Only)

This menu option appears only when using a Masimo module and sensor.

- Normal: Use the Normal sensitivity setting for normal patient monitoring purposes.
- Maximum: Use the Maximum sensitivity setting for improved low perfusion performance and for faster tracking of rapid MSp02 saturation changes.

Averaging Time (Masimo Module Only)

This menu option only appears when using a Masimo module and sensor. Choose a response time in order to compensate for different levels of patient activity: 2, 4, 8, 10, 12, 14, or 16 seconds.

For the 2 and 4 second averaging settings: The actual averaging times may range from 2 to 4.

- 10, 12, 14, or 16 seconds: These averaging settings are least affected by patient movement.
- 8 seconds: This averaging selection is recommended in cases where the patient is relatively inactive.
- 2, 4 seconds: These averaging selections are most affected by patient movement.

Print Interval

This setting determines the time interval for printing the $MSpO_2$ values on the strip chart paper.

$\%O_2$ Trace

This setting enables or disables the printing of the $\%MSpO_2$ trend on the bottom grid of the strip chart paper.

- **On:** The $\%MSpO_2$ trend prints in grey and is annotated with $\%MSpO_2$ ⌐⋀⋀.
- **Off:** The $\%MSpO_2$ trend is not printed.

Alarm Limits

These fields adjust the high and low alarm limits for $\%MSpO_2$, as well as for MHR/P—in increments of 1% or 5 BPM.

Audio Alarm

This field enables/disables the audio alarm function for $MSpO_2$.

- **On:** Visual and audible indications are provided during an $MSpO_2$ alarm condition.
- **Off:** Only a visual indication is provided during an $MSpO_2$ alarm condition.

Alarm Volume

This field controls the alarm volume.

MHR/P Setup Screen

Select the mode title softkey—MECG or PULSE—to access the MHR/P Setup screen (Figure 5-5).

NOTE: Figure 5-5 provides an example where MECG is selected as the MHR/P source, as indicated by the MECG mode title. If either MSpO2 or NBP is selected as the MHR/P source, the mode title would change to PULSE.

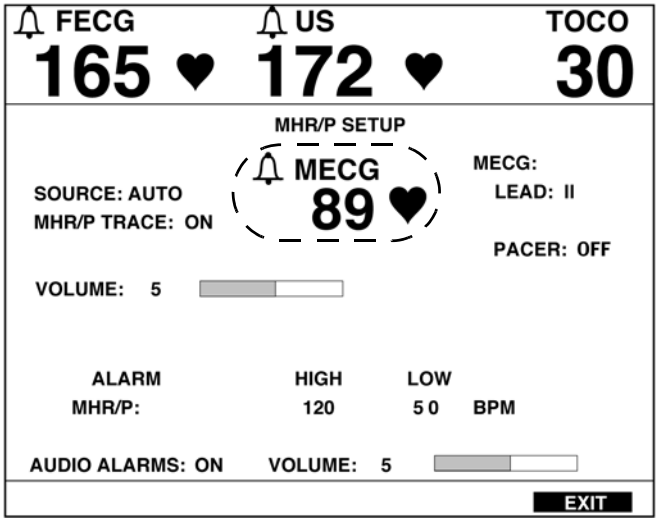


Figure 5-5. MHR/P Setup Screen: MECG as the MHR/P Source

Source

This field selects the MHR/P source. When AUTO is selected, the monitor checks for parameter availability and use in the following order: MECG, $MSpO_2$, then NBP. If a source is not available, the next available source is automatically selected.

IMPORTANT
WAVEFORM—The MHR/P Source field is independent of the waveform selected on the normal operating screen. For example, you can select MECG as the MHR/P source yet display the $MSpO_2$ plethysmograph waveform. Or, you can select $MSpO_2$ as the source and display MECG as the waveform.

MHR/P Trace

This field enables or disables the printing of the MHR/P trace on the strip chart paper.

- **On:** The MHR/P trend is printed in grey annotated with MECG or $MSpO_2$ P —whichever parameter is selected in the MHR/P source field. MHR/P data from NBP is not trended since blood pressure determinations are static measurements.
- **Off:** The MHR/P trend is not printed.

Volume

This field sets the volume of the “beep” sounded with each detected valid heartbeat—for MECG and MSpO$_2$ only.

Alarm Limits

These fields adjust the high and low alarm limits for MHR/P— in increments of 5 BPM. The selectable values are shown in Figure 5-5. The factory defaults are listed in Appendix A, “Factory Defaults” .

Audio Alarms

This field enables/disables the audio alarm function for MHR/P.

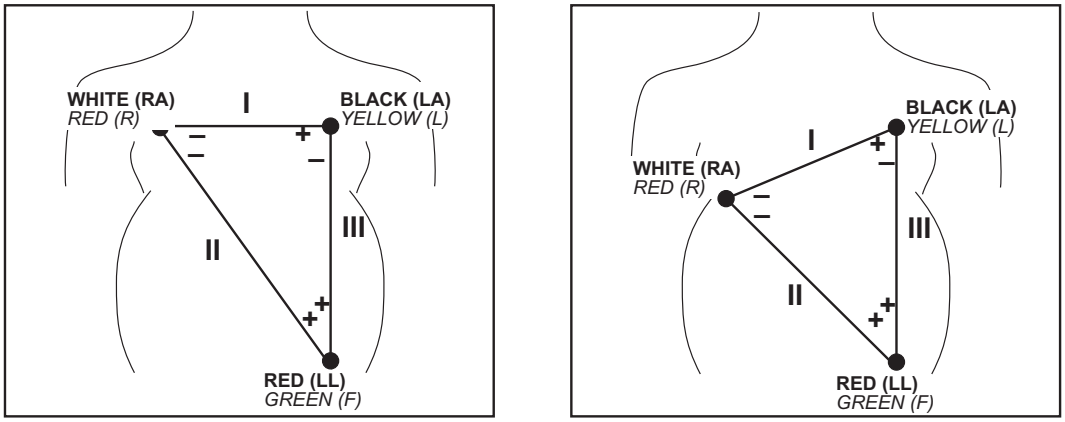
- **On:** Visual and audible indications are provided during an MHR/P alarm condition.
- **Off:** Only a visual indication is provided during an MHR/P alarm condition.

Alarm Volume

This field controls the alarm volume.

MECG Lead

This field selects the ECG lead configuration. The lead can also be selected from the MECG Lead Softkey on the normal operating screen Lead I refers to the potential between the left arm and the right arm. Lead II refers to the potential between the right arm and left leg.
Lead III refers to the potential between the left arm and the left leg. Figure 5-6 illustrates which electrodes reference the ECG lead obtained.



Typical Patient

Pacemaker Patient

NOTE: AHA label **bolded**; IEC label *italicized.*

Figure 5-6. MECG Lead Selection Guide

MECG Pacer

This field enables/disables pacemaker pulse rejection circuitry.

- **Off:** Use this setting for a patient without a pacemaker. All ECG events are monitored; all complexes, including pacer spikes may be displayed and may be included in the heart rate calculation.
- **On:** Use this setting for a patient who has a pacemaker. The monitor rejects the pacer spike from the heart rate calculation and replaces the actual pacer spike with a pacer event mark; in addition the letter **P** is displayed prior to the waveform speed. Figure 5-7 shows an example of an MECG waveform with the MECG pacer ON.

Response Time

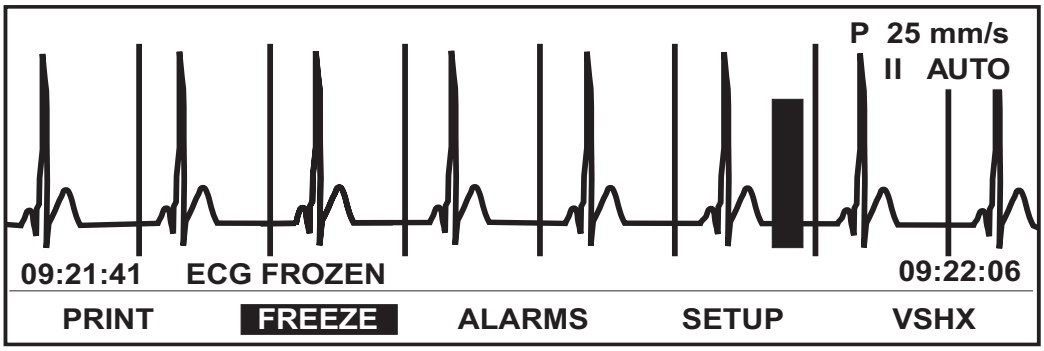


Figure 5-7. Response Time

Master Alarm Setup Screen

Select the ALARMS softkey to display the Master Alarm Setup screen (Figure 5-8). Each of the fields on this screen can be accessed under the individual parameter setup screens. For available settings, refer to Appendix A, “Factory Defaults” .

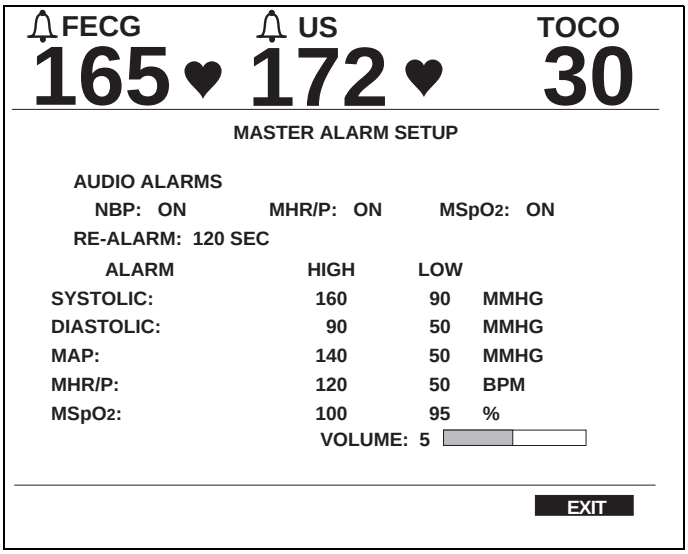


Figure 5-8. Master Maternal Alarm Setup Screen

Audio Alarms

Individual fields enable/disable the audio alarm functions for NBP, $MSpO_2$, and MECG. The settings are summarized as follows:

- **Off:** Only a visual indication is provided for an alarm.
- **On:** Both visual and audible (if enabled) indications are provided for an alarm condition.

Re-Alarm

When an audio alarm is cancelled using the Alarm Silence pushbutton, the audible indication is removed. However, for MECG and $MSpO_2$ monitoring and during a paper-load–error condition, an alarm will be re-issued if the alarm state continues after a specified amount of time. This field adjusts the temporary silence period.

Alarm Limits

These fields adjust the high and low alarm limits for NBP, MHR/P, and $MSpO_2$.

Volume

This field controls the volume of *all* alarms.

$FSpO_2$ Setup Screen

Select the FSPO2 softkey to access the $FSpO_2$ Setup screen (Figure 6-2).

IMPORTANT
SOFTKEY ACTIVATION—The Corometrics fetal patient module cable must be plugged into the FSpO2 connector in order to activate the FSpO2 mode softkey.

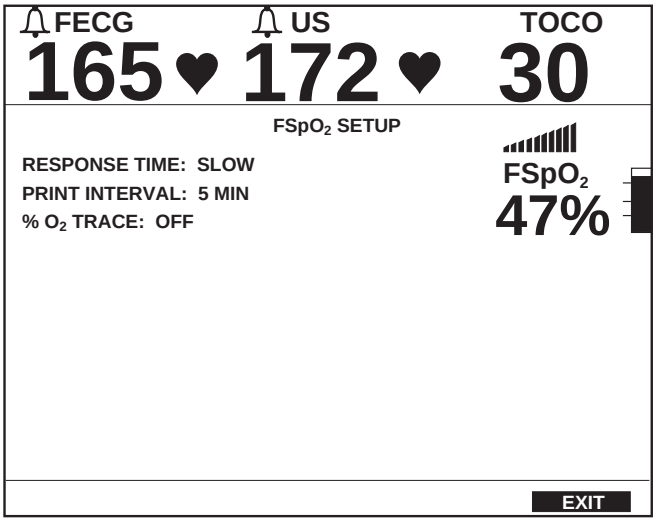


Figure 5-9. $FSpO_2$ Setup Screen

Response Time

This field sets the response time or averaging mode (the time the monitor takes to respond to changes in fetal oxygen saturation).

- **Slow:** The $FSpO_2$ display responds to step changes in the fetal saturation with approximately 120 accepted pulses, or in about 50 seconds at 150 BPM.
- **Fast:** The $FSpO_2$ display responds to step changes in the fetal saturation with approximately 30 accepted pulses, or in about 11 seconds at 150 BPM. (The factory default setting is SLOW.)

When signal quality is poor, the response time becomes longer regardless of the mode selected.

Print Interval

This setting determines the time interval for printing the $FSpO_2$ values on the strip chart paper.

%O_2 Trace

This setting enables or disables the printing of the %$FSpO_2$ trend on the bottom grid of the strip chart paper.

- **On:** The %$FSpO_2$ trend is printed as a beaded trace on the bottom (or right) grid annotated by %$FSpO_2$ —▪—.
- **Off:** The %$FSpO_2$ trend is not printed.

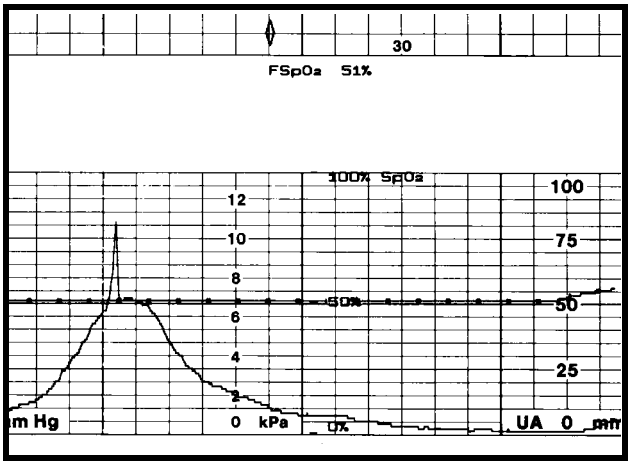


Figure 5-10. $FSpO_2$ Trend

$FSpO_2$ Display Area

Single versus Dual Display of SpO_2

If $FSpO_2$ is monitored while $MSpO_2$ is inactive, $FSpO_2$ displays in the Additional Parameters Area. Refer to Figure 6-4. When dual SpO_2 monitoring occurs, $FSpO_2$ information is displayed in the Waveform Area beneath the $MSpO_2$ area. Any waveform labels (speed, lead, scale) move to the left of the $FSpO_2$ area. The waveform area, which would otherwise display about 4 seconds of information, is reduced to show approximately 2.5 seconds of waveform data. Refer to Figure 6-5.

$FSpO_2$ Status Icons

A status icon may appear above the %$FSpO_2$ value to provide additional information. Usually the message area will be blank; however, the icons representing Sensor Unplugged, Sensor Lifted, or Searching for Fetal Pulse can appear.

Sensor Unplugged – This icon appears whenever: the $FSpO_2$ sensor is disconnected from the fetal patient module cable; when the fetal patient module cable is disconnected from the monitor; or when an invalid $FSpO_2$ sensor is connected to the fetal patient module cable.

Sensor Lifted – This icon appears whenever the sensor is not making adequate contact at the sensor site on the fetus.

Pulse Search – This icon is displayed when the monitor is attempting to locate the fetal pulse. During successful monitoring, the message area is blank.

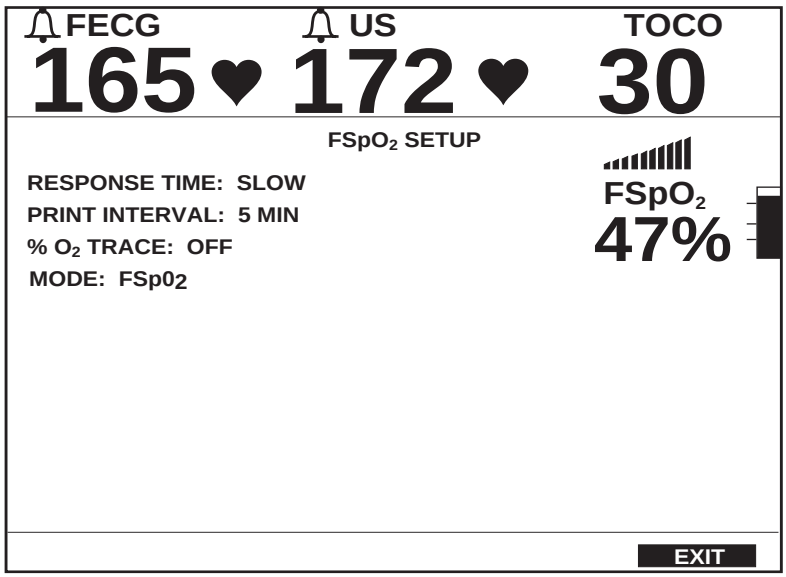


Figure 5-11. Display of Fetal Pulse Oximetry

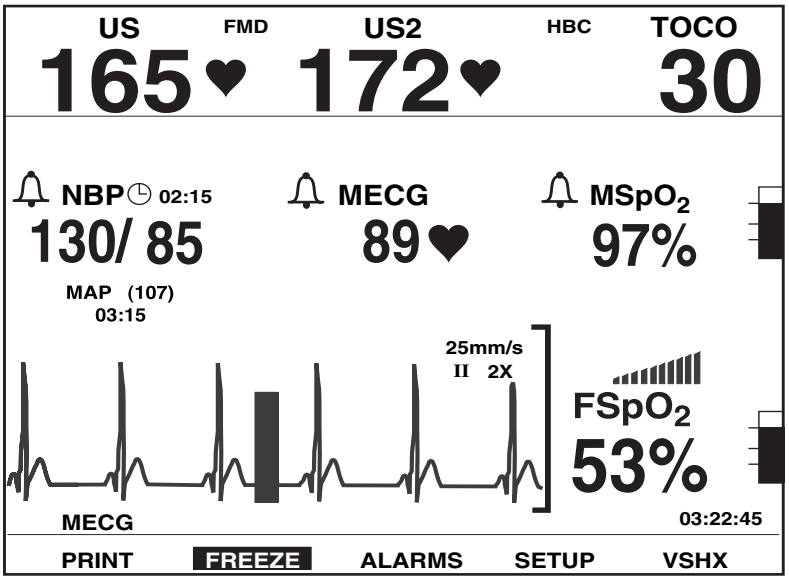


Figure 5-12. Simultaneous Display of Fetal and Maternal Pulse Oximetry

General Setup Screen

Select the SETUP softkey to display the General Setup screen (Figure 5-13).

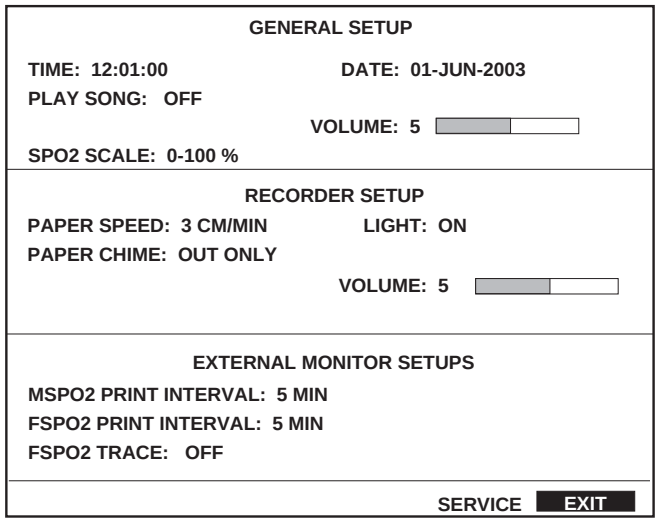


Figure 5-13. General Setup Screen

Time

It is very important to set the monitor's clock prior to initial operation and during daylight-saving time changes. A long-lasting battery maintains the set time even when the monitor is unplugged from AC power.

The time is represented by a 24-hour clock in hours, minutes, and seconds. The hour field has a range from 00–23; the minutes field has a range from 00–59; the seconds field is not adjustable.

Date

It is very important to set the date on your monitor prior to initial use. The month field has a range from 01–12; the range for the day field varies according to the selection for month and year*; the year field has a range of 00–99. A long-lasting battery maintains the date even when the monitor is unplugged from AC power.

Song Player

You can activate a song to be played from the monitor's speaker to celebrate each birth.

Song Player Volume

This field sets the volume of the song player.

* *For example: February of 1996 has a day range of 01–29; February of 1997 has a day range of 01-28; August of 1997 has a day range of 01–31.*

SpO_2 Scale

Two scale options are available for printing the %MSpO_2 trend, for compatibility with %FSpO_2 trending. (%FSpO_2 is *always* trended on a scale of 0–100 %.) The scale is printed on the paper along with the trend.

- **Auto:** If only the %MSpO_2 trend is printing, the trend plots on an expanded scale of 60–100 % or 50–100 %, depending on the paper.* Whenever the %FSpO_2 is being trended, the monitor automatically switches to a scale of 0–100 % for both %MSpO_2 and %FSpO_2.)
- **0–100 %:** This option configures the %MSpO_2 trend to always plot at a fixed scale of 0–100 % — even when the maternal trend prints alone.

Paper Speed

This field selects the paper speed of the strip chart recorder.

Paper Chime

This field enables/disables an audible tone to indicate a low-paper or out-of-paper condition.

Recorder Light

This field turns the recorder light on and off. This light permits the room lights to be dimmed without sacrificing visibility of the strip chart recorder. A patient can remain resting, without the disturbance of overhead lights, while a nurse or physician checks the strip chart.

IMPORTANT

RECORDER LIGHT—The recorder light is only available on monitors purchased with Software Version 3.0 or greater. Older monitors can be upgraded to Software Version 3.0 or greater; however, the recorder light will not be available. If your monitor has a recorder light: the LIGHT field displays on the General Setup screen; and a frosted plastic light cover is located above the strip chart recorder.

* *The %MSpO_2 trend is plotted over a range of 60–100 % on paper with a HR scale of 30–240 BPM. The %MSpO_2 trend is plotted over a range of 50–100 % on paper with a HR scale of 50–210 BPM.*

Paper Chime Volume

This field sets the volume of the paper chime. As you adjust the volume, a sample tone sounds.

$MSpO_2$ Print Interval

This field sets the time interval for printing $MSpO_2$ values received from an ***external*** maternal pulse oximetry monitor.

$FSpO_2$ Print Interval

This field sets the time interval for printing $FSpO_2$ values received from an ***external*** fetal pulse oximetry monitor.

$FSpO_2$ Trace

This field enables/disables $\%FSpO_2$ trend trace printing of data received from an ***external*** fetal pulse oximetry monitor.

Service Mode Screens

The 120 Series Monitor is programmed with five service mode screens. These screens are listed below:

- Service Lock
- Install Options
- Error Log (Refer to "Chapter 8, Self-Tests".)
- Communications Setup (Also, refer to "Chapter 11, Peripheral Devices".)
- Diagnostic Control (Refer to "Chapter 8, Self-Tests".)

Service Lock Screen

The Service Lock screen, Figure 5-14, displays the CPU and DSP software version numbers and is used to access the remaining service screens. A password is required to prevent unauthorized users from accessing the service mode screens.

To display the Service Lock screen:

1. Select the **SERVICE** softkey from the General Setup screen.
2. The Service Lock screen appears and the access code is displayed as **0 0 0 0**.
3. Use the Trim Knob control to set the access code to the current month and day. For example: April 23 is 0 4 2 3. March 28 is 0 3 2 8.

NOTE: The correct date and time must be set on the General Setup screen or you will not gain access to the service screens.

4. As soon as you enter the correct access code, the Install Options screen displays.

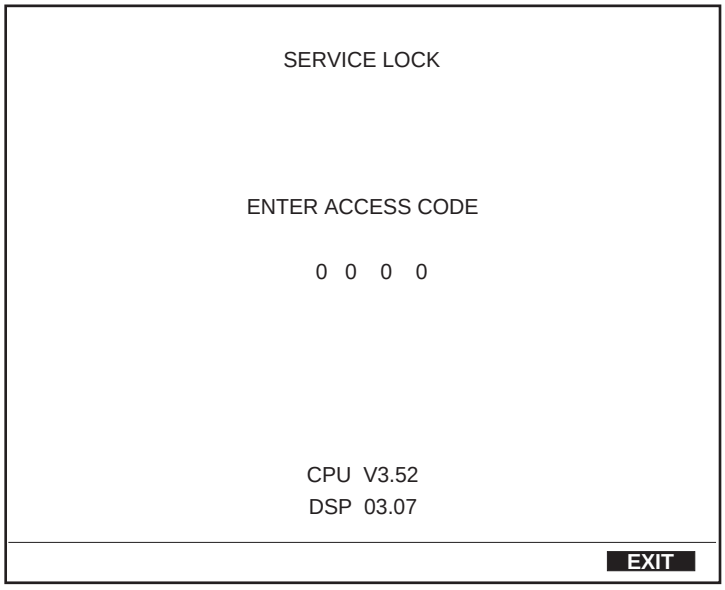


Figure 5-14. Service Lock Screen

Install Options Screen

Use the Install Options screen (Figure 5-15) to:

- select the default settings used when the 120 Series Monitor is turned on;
- select the line frequency;
- enable/disable ECG artifact elimination;
- configure the recorder's vertical scale;
- select the language used on the display and printed on the strip chart paper;
- enable/disable a one-minute blood pressure interval selection on the maternal BP Setup screen;
- enable/disable the secondary heart rate offset feature;
- select the uterine activity baseline value used when a tocotransducer is in use and you press the **UA Reference** pushbutton;
- set the type of mark printed when a patient presses the button on the Remote Event Marker accessory;
- enable/disable Corolan address checking circuitry;
- enable/disable the heartbeat coincidence feature;
- enable/disable the Smart BP feature;
- select between real-time and chart-style vital signs history intervals;
- select the recorder font size;
- select between fetal alerts and alarms (if the Spectra Alerts option is installed);
- enable/disable the alert suspend feature (if the Spectra Alerts option is installed);
- print all the setup settings on the strip chart recorder;
- print the error log (refer to "Chapter 8, Self-Tests");
- access the Communications Setup screen; and
- access the Diagnostic Control screen.

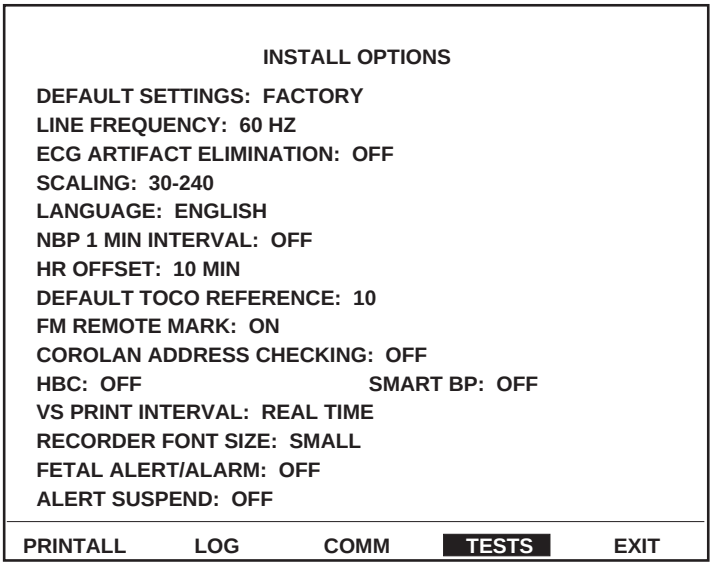


Figure 5-15. Install Options Screen

To access the Install Options screen:

1. Select the **SERVICE** softkey from the General Setup screen.
2. The Service Lock screen appears and the access code is displayed as **0 0 0 0**.
3. Use the Trim Knob control to set the access code to the current month and day. For example: April 23 is 0 4 2 3. March 28 is 0 3 2 8.

NOTE: The correct date and time must be set on the General Setup screen or you will not gain access to the service screens.

4. As soon as you enter the correct access code, the Install Options screen displays.

Default Settings

Factory Defaults

Factory defaults represent settings chosen to meet the requirements of a typical labor and delivery environment. If the monitor is set to the FACTORY option, the monitor will power up with the settings that are listed in Appendix A, "Factory Defaults" .

You may adjust the setup screen configurations as needed during monitoring; however, be advised that if you turn off the monitor, all user setup screens revert to the factory defaults when the monitor is turned on again.

Current (Last-Used) Settings

If you monitor intermittently *and* configure the monitor for each patient, the CURRENT option may be right for you. This option causes the monitor to power up with the last used settings—stored in battery-backed memory.

Hospital Defaults

The NEW HOSPITAL option allows your hospital to configure its own set of preferences to be used each time the monitor is powered on. Record your hospital settings in Appendix A, "Factory Defaults" for reference. Once the settings have been defined, this option changes to read HOSPITAL-WIDE.

You may adjust the setup screen configurations as needed during monitoring; however, be advised that when you turn off the monitor, all user setup screens revert to the hospital-defined preferences when the monitor is turned on again.

Volume Exceptions

The monitor is shipped from the factory with the FHR volumes set at 5. However, the volume on the FECG, US, US2, or MHR/P Setup screen ***is not*** stored as part of any power-on set (Factory, Current, or Hospital-Wide). Regardless of how you set the volume (using a setup screen or the Volume buttons):

- If the volume setting at power-off is in the range 0–7, that volume remains set at power-on.
- If the volume setting at power-off is in the range 8–9, the volume is adjusted to 5 at power-on.

New Hospital

To define hospital-wide menu settings for the first time, or to re-define existing settings:

1. Select NEW HOSPITAL in the Defaults field on the Install Options screen.
2. Exit the service mode.
3. Configure each of the user setup screens as desired.
4. Cycle power on the monitor.

Line Frequency

This field is used to define the line power frequency for the country in which the monitor is being used. Use the Trim Knob control to alternate between 50 Hz and 60 Hz. (The monitor is factory set for the country in which it is being used.)

ECG Artifact Elimination

This field is used to enable/disable ECG artifact elimination which affects only the direct FECG mode. Use the Trim Knob control to alternate between ON and OFF. (The factory default setting is OFF.) When ON is selected, any new heart rate value which differs by more than ±25 BPM from the previously calculated heart rate is not printed on the strip chart paper. When OFF is selected, all heart rate values are printed on the strip chart paper without regard to previous rates.

Scaling

This field is used to set the heart rate scale for the strip chart paper. Use the Trim Knob control to alternate between 30–240 (BPM/cm) and 50–210 (BPM/cm). (The monitor is factory set for the country in which it is being used.) The $MSpO_2$ trend *expanded* scale is also affected by this setting. When the heart rate scale is 30–240, the $MSpO_2$ expanded scale is 60–100 % (10%/cm). When the heart rate scale is 50–210, the $MSpO_2$ expanded scale is 50–100 % (12.5%/cm).

Language

This field is used to set the language shown on the display and printed on the strip chart recorder paper. Use the Trim Knob control to cycle through the available options: ENGLISH, SPANISH, FRENCH, GERMAN, and ITALIAN. (The monitor is factory set for the country in which is it being used.)

NBP One-Minute Interval

This field is used to enable/disable the one-minute interval selection on the maternal BP Setup screen. Use the Trim Knob control to alternate between ON and OFF. (The factory default setting is OFF.)

HR Offset

This field is used to enable/disable the secondary offset feature. Use the Trim Knob control to cycle through the available options: 10 MIN, ON, and OFF. (The factory default setting is 10 MIN.)

What is it?

When monitoring dual heart rates using US/US2 or FECG/US, overlapping traces may be difficult to interpret. All 120 Series Monitors provide a +20 BPM shift for the secondary fetal heart rate trend to alleviate this problem. When using US/US2 or FECG/US2, and the US2 trace is shifted +20 BPM, the US2+20 symbol prints on the upper portion of the top grid every 4.5 cm. When using US/FECG, and the US trace is shifted +20 BPM, the US + 20 symbol prints on the upper portion of the top grid every 4.5 cm. In both cases, an arrow (→) and a vertical dashed line are printed to draw attention to the start of the shifted trend.

10 Min

The heart rate offset mode is enabled with an auto-revert feature. If the trace is shifted by the user, the heart rate will revert back to the normal (unshifted) level after 10 minutes.

On

The heart rate offset mode is enabled. If the user shifts a trace, the trace will remain shifted until the user manually sets the trace back to normal (unshifted level).

Off

The heart rate offset mode is disabled. The user cannot shift traces.

NOTE: Refer to the operator's manual for information about activating the heart rate offset mode.

Default TOCO Reference

This field sets the *default* uterine activity pressure reference for the tocotransducer. Use the Trim Knob control to cycle through the available settings: 5, 10, 15, 20, or 25 relative units. (The factory default setting is 10 relative units.)

When using a tocotransducer, *momentary* depression of the **UA Reference** button sets the pressure baseline at the *default* setting.

Pressing the **UA Reference** button for more than two seconds causes the UA reference value to override the default setting and cycle through all available selections: 5, 10, 15, 20, or 25 relative units, starting at the *default* setting until the button is released. This value is stored as the new baseline for the currently measured uterine activity signal; as soon as the **UA Reference** button is momentarily pressed, the baseline returns to the *default* value.

FM Remote Mark

This field configures the marker annotation that is printed on the strip chart paper whenever a patient presses the button on the Remote Marker accessory. Use the Trim Knob control to alternate between ON and OFF. The factory default setting is OFF.

The annotation is commonly used to record an "event"; while the FM annotation is commonly used as an indication that the mother has perceived fetal movement.

Corolan Address Checking

This field enables/disables Corolan address checking. Use the Trim Knob control to alternate between ON and OFF. (The factory default setting is OFF.) If the monitor is not a device on a Corolan daisy-chain network, configure this field to OFF. If the monitor is a device on a Corolan daisy-chain network, configure this field to ON. When this option is set to ON, the monitor periodically performs an address and LED test on the Corolan wallplate the monitor is attached to; if the monitor detects an error it stores this information in the error log and the monitor automatically goes offline from the Corolan network.

Heartbeat Coincidence

The heartbeat coincidence feature alerts you when there is the possibility that you may be monitoring a duplicate signal. Heartbeat coincidence is indicated when any two heartbeats have a consistent phase relationship for equal to or greater than 60% of the detected beats for about 60 seconds; the cessation of coincidence is indicated when the phase relationship is inconsistent for greater than 40% of the detected beats for about seven seconds.

When heartbeat coincidence detection is *enabled*, the acronym HBC appears to the right of the FHR2 mode title.

Smart BP

Models 128 and 129 have a Smart BP feature which prevents an automatic blood pressure determination from occurring during a uterine contraction. This feature:

- reduces the chances for erroneous vital signs readings; and
- reduces patient discomfort during labor.

VS Print Interval

The monitor provides an option for the printing of blood pressure and MSpO2 values on the strip chart paper:

- **Real-Time:** Values are printed according to the actual clock time (9:33, 9:48, 10:03, etc.).
- **Chart-Style:** Values are printed on standard clock quarter (9:00. 9:15, 9:30:, 9:45, etc), half (9:00, 9:30, 10:00, 10:30, etc), and whole hour marks (9:00, 10:00, 11:00, 12:00, etc).

Recorder Font Size

The monitor offers a choice of font sizes to print annotations.

- **Small:** increases print speed.
- **Medium:** a compromise between the large and small sizes.
- **Large:** fosters readability.

Fetal Alert/Alarms

If the Spectra Alerts option is installed in your monitor, use this field to select between the built-in FHR alarm features of the monitor and the Spectra Alerts option.

- **Alarms:** The monitor generates alarms based on the limit settings provided on the FHR setup screens.
- **Alerts:** Enables the Spectra Alerts feature to analyze heart rate and uterine activity data to detect certain abnormal trends and alert the clinician.

Alert Suspend

When a care provider is at the patient's bedside, it may be desirable to suspend the audio component of alerts.

- **Off (disabled):** users are unable to suspend audio alerts.
- **On (enabled):** users can manually activate/de-activate the function.

Printing System Setup Information

Use the Trim Knob control to select the PRINTALL softkey on the bottom of the Install Options screen to see an overall summary of the monitor's setup screens. A screen capture of each system setup screen (user and service) is printed on the strip chart paper. The following screen summaries are printed:

- Diagnostic Control
- Communications Setup
- Install Options
- General Setup
- Master Alarm Setup
- Vital Signs History
- $FSpO_2$ Setup
- $MSpO_2$ Setup
- MHR/P Setup
- NBP Setup
- FECG Setup
- US Setup
- US2 Setup

NOTE: The FECG, US, and US2 Setup screens are shown together in one group. In addition, the HR Offset field is separated on this summary screen, since it may appear on either the US or the US2 Setup screen—depending on the active connectors.

Figure 5-16 shows a portion of a sample printout.

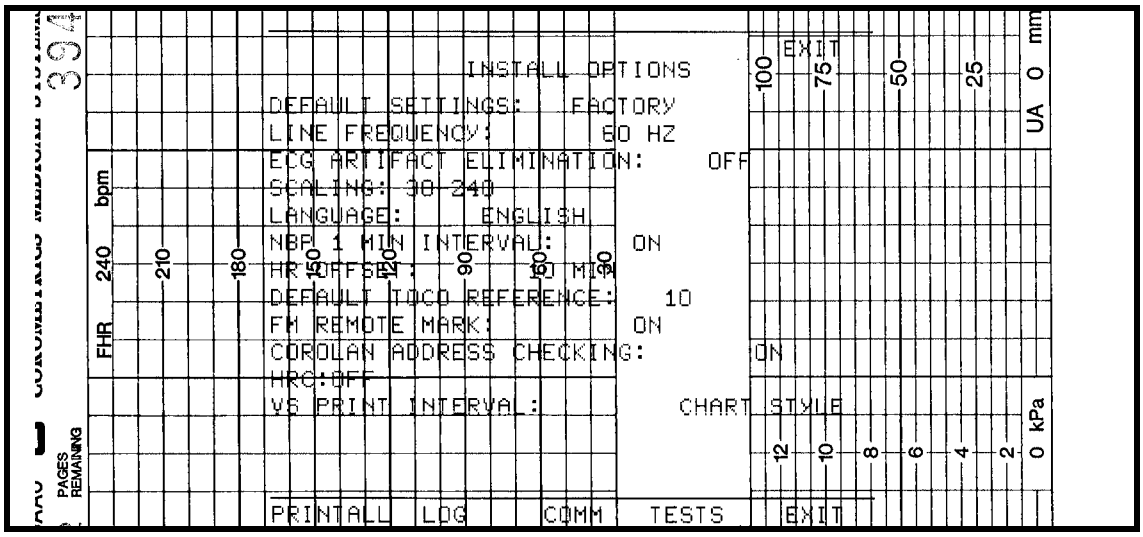


Figure 5-16. Install Options Portion of System Setup Printout

Communications Setup Screen

The Communications Setup screen, allows you to configure the unit's J109, J110, and J111 RS-232C Serial Interface ports for connecting to optional peripheral equipment. Each port is configured for baud rate and mode.

To use the Communications Setup screen:

1. Select the **SERVICE** softkey from the General Setup screen.
2. The Service Lock screen displays.
3. Enter the correct access code; the Install Options screen displays.
4. Select the **COMM** softkey on the Install Options screen.
5. The Communications Setup screen appears.

Baud Rate

This field selects the baud rate for communication with an external device. Use the Trim Knob control to cycle through the available settings: 600, 1200, 2400, 4800, 9600, and 19,200 bps. (Each port is factory set to 2400 bps.) Refer to "Chapter 11, Peripheral Devices", for more information about configuring this field.

Mode

This field selects the mode for communication with an external device. Use the Trim Knob control to cycle through the available settings: NELLCOR, FACTORY, CRITIKON, 1371, 1371/NOTES, LOOPBACK, 115 UPDATE, and 115 TRANSMIT/RECEIVE. (Each port is factory set to the NELLCOR mode.) Refer to "Chapter 11, Peripheral Devices", for more information about configuring this field.

NOTE: At the factory default settings of 2400 bps and the NELLCOR mode, connectors J109 and J111 are ready for connection to a Nellcor Puritan Bennett (NPB) Model N-200 or Model N-400. Be advised that connector J110 does not support a connection to a NPB monitor; therefore, this connector will have to be configured for use with another device, if appropriate.

Hardware Switches

The 120 Series Monitor Main Motherboard contains one dip switch pack SW1, which is used to:

- enable/disable a factory test mode (for factory use only);
- select between Corometrics- or Hewlett-Packard–compatible outputs from the rear panel J102 connector;
- set the clock speed;
- enable disable the $FSpO_2$ option;
- enable/disable the maternal NBP option;
- enable/disable the $MSpO_2$ option; and
- enable/disable the MECG option.

To configure these switches:

1. Turn off the 120 Series Monitor and disconnect the power cord from the monitor.
2. Remove the nine screws which secure the monitor top cover. Four screws are located on the bottom of the monitor and five screws are located in the back.
3. Remove the cover by sliding it toward the rear of the monitor.
4. Set the switches according to Table 5-1.
5. Replace the monitor top cover and secure with all nine screws.
6. Re-connect the power cord and turn on the monitor.

Table 5-1. Hardware Switch Settings

Switch #	Description	On (0) Position	Off (1) Position
1	Factory Test	Disabled	Enabled
2	J102 Output Levels	Corometrics	Hewlett-Packard
3	Unused	—	—
4	Clock Speed	16 MHz	20 MHz
5	$FSpO_2$ Option	Disabled	Enabled
6	NBP Option	Disabled	Enabled
7	$MSpO_2$ Option	Disabled	Enabled
8	MECG Option	Disabled	Enabled

Chapter 6

Functional Checkout Procedure

NOTE: Read each step of this procedure thoroughly prior to performing the tests.

This chapter contains the following:

Before You Begin 6-2
Self-Test Routine 6-3
Front Panel Pushbutton Test 6-5
Connecting the Simulator 6-6
MECG Test 6-7
FECG Test 6-11
Ultrasound Test 6-16
Fetal Movement Detection Test 6-19
Ultrasound Transducer Test 6-21
Uterine Activity Test 6-22
Tocotransducer Test 6-25
Strain Gauge Transducer Test 6-26
Pattern Memory Test 6-27
Dual Heart Rate Test (Non-Pattern) 6-28
Alarm Test 6-32
MSpO2 Test 6-35
NBP Test 6-35
Preventative Maintenance Inspection Report 6-35

Before You Begin

Like all electronic monitoring devices, internal and external components are subject to fatigue, wear, and the potential for failure over time and under varying conditions of use. Additionally, events such as dropping the monitor, spilling liquids on the monitor, or crimping the lead wires or patient cables can cause damage which may affect the overall system performance. Therefore, between factory service visits it is necessary that the proper operation of each monitor be verified by performing the functional checkout procedure described in this section. This procedure should be completed prior to initially placing the monitor on a patient, when monitor performance needs to be verified, on a semi-annual basis, or more frequently as dictated by your equipment maintenance and management policies.

Equipment Required

The following items are necessary for performing any of the tests in this procedure:

- Corometrics Model 325 Simulator and corresponding line cord
- 120 Series Monitor interconnect cables
- Ultrasound Transducers (x2)
- Tocotransducer
- Strain Gauge Transducer

General

Visually inspect the monitor, patient cables, and other accessories for cracks, fissures, or other signs of wear or damage. Do not use any monitor or accessory which appears to be worn or damaged. If unsure, contact your GE Service Representative to arrange for evaluation, replacement, or repair of the suspect item(s).

Self-Test Routine

The 120 Series Monitor contains test routines which verify the unit's calibration and internal circuitry. These routines are initiated by depressing the front panel **Test** pushbutton. The test results are printed on the strip chart recorder paper, verifying the integrity of the unit.

It is recommended practice to initiate the self-test feature at the beginning of each monitoring session.

1. Check the **Voltage Selection** switch on the rear panel of the 120 Series Monitor and ensure it matches the line voltage of the receptacle to be used. Connect the detachable line cord to the rear panel power entry module; plug the other end into a hospital grade, grounded wall outlet of appropriate voltage.
2. Place the front panel **Power** switch in the *on* (**I**) position. When the power is first turned on, verify that three tones are emitted from the rear panel speaker and the green power on indicator is lit.
3. Depress the front panel **Test** pushbutton and verify the following:
   - All display pixels illuminate for one second and then all are extinguished for one second. Afterwards, a vertical line moves across the screen from left to right, followed by a horizontal line moving from top to bottom. The display then remains black.
   - The yellow **Record** indicator illuminates.
   - The message TEST: ARE ALL DOTS PRINTED? is printed followed by two vertical lines which should appear continuous. Discontinuous lines may be an indication of damaged printhead elements if gaps occur in the same place on both lines. Simulated trends of 30 and 240 BPM (or 50 and 210 BPM, depending on the paper installed) are printed on the top grid. Simulated pressure trends at 0 and 100 mmHg are printed on the bottom grid. The values are also printed in the center margin of the strip chart. Refer to Figure 6-1.
   - After the recorder test above, the display returns to the main screen; then the software generates a 120 BPM rate in the FHR1 area and a 180 BPM rate in the FHR2 area, with both mode titles displaying **TEST**.
   - The monitor adds 50 mmHg to the present pressure level and displays this value in the UA display area; the mode title displays **TEST**.

NOTE: The monitor will add 50 mmHg to raw pressure data. In other words, the value is always referenced to 0 mmHg regardless of any UA referencing attempt.

4. The recorder returns to its original on, off, or maternal-only mode state from when the **Test** pushbutton was depressed.

NOTE: To disable the test, depress the **Test** pushbutton or open the recorder door.

NOTE: If the simulated fetal heart rate trends do not appear in the correct positions on the strip chart recorder paper, ensure the monitor's vertical scale setting matches the type of paper being used, i.e. 30 BPM/cm or 20 BPM/cm. (Refer to"Install Options Screen" on page 5-26.)

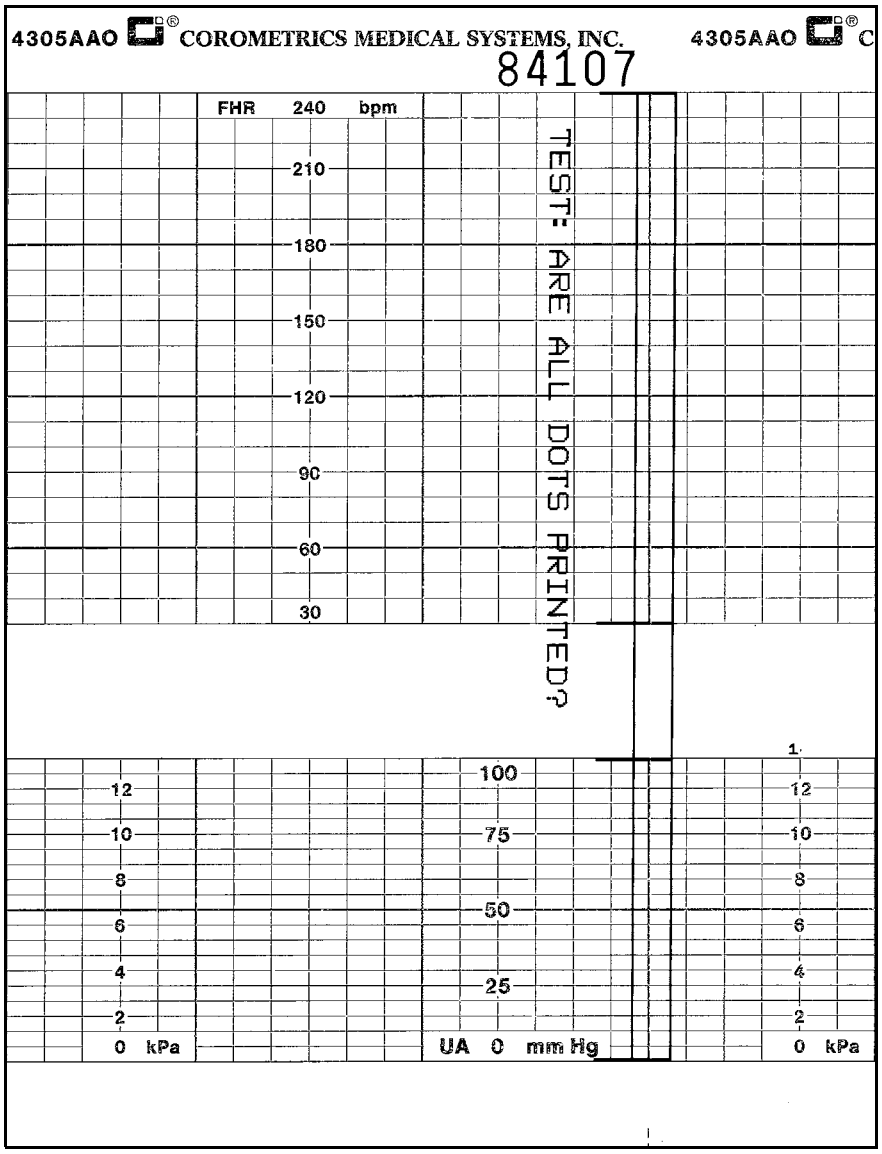


Figure 6-1. 120 Series Self-Test

Front Panel Pushbutton Test

This procedure ensures the functionality of the front panel pushbuttons.

1. Apply power to the 120 Series Monitor.
2. Disconnect all transducers from the front panel.
3. Access the General Setup screen and set the recorder speed to 1 cm/min; then exit the setup screen.
4. Depress the monitor's **Record** pushbutton and verify the following:
   - The yellow indicator next to the pushbutton illuminates continuously.
   - The recorder paper advances at a rate of 1 cm/min.
   - The recorder prints the correct time and date information on the strip chart paper. (If an incorrect time or date is listed, refer to "Chapter 5, Setup Procedures" in this manual.)
   - The recorder prints the messages CARDIO INOP and UA INOP, indicating that no ultrasound, ECG, or uterine activity transducers are plugged into the front panel **US**, **US2**, **FECG/MECG**, or **UA** connectors.
   - The recorder prints the message 1 CM/MIN, indicating the selected chart speed.
5. Depress and hold the monitor's front panel **Paper Advance** pushbutton and verify that the recorder paper advances at a rate of 40 cm/min.
6. Release the **Paper Advance** pushbutton and verify that the recorder prints the message 1 CM/MIN.
7. Access the General Setup screen and set the recorder speed to 3 cm/min; then exit the setup screen.
8. Verify that the recorder paper advances at a rate of 3 cm/min. and that after approximately 40 seconds, the message 3 CM/MIN is printed on the recorder paper. (The time, date and monitoring modes are also printed again.)
9. Depress the monitor's front panel **Mark** pushbutton and verify that an event mark (↑) is printed on the bottom two lines of the recorder paper.

Connecting the Simulator

This part of the procedure prepares the simulator for use.

NOTE: You must use a Model 325 Simulator for the functional checkout procedure. (Monitors in the 120 Series do not work with Model 305 Simulators.)

1. Ensure the Model 325 **Power** switch is in the *off* position.
2. Connect the Model 325 Simulator's power cord to the power receptacle on the rear panel of the simulator; plug the other end of the power cord into a properly grounded wall outlet of appropriate voltage.
3. Ensure the 120 Series Monitor **Power** switch is in the *off* position.
4. Connect the simulator interconnect cable's 50-pin end to the simulator's **Fetal Monitor** connector.
5. Insert the green plug of the FECG/MECG adapter cable, cat. no. (REF) 1442AAO, into the monitor's **FECG/MECG** connector.
6. Connect the sub-cables of the other end of the simulator interconnect cable into the color-coded connectors on the monitor/adapter: **ECG**, **US**, and **UA**.
7. Turn *on* the Model 325 Simulator. Verify that the green **Power** indicator illuminates.
8. Turn *on* the 120 Series Monitor.

MECG Test

This portion of the functional checkout procedure ensures the integrity of the MECG circuitry and the heart rate channel of the recorder.

1. Connect the simulator's ECG sub-cable to the **MECG** connector on the monitor adapter cable.
2. Connect the simulator's UA sub-cable to the **UA** receptacle on the monitor.
3. Set the switches on the Model 325 Input Simulator according to Table 6-1.
4. If not already on, depress the monitor's **Record** pushbutton.
5. Turn the simulator's **Manual Adjustment** knob fully counterclockwise and verify the following on the monitor's display:
   - The MHR value is 30 BPM.
   - The MHR/P mode is **MECG**.
   - The MHR heartbeat indicator (♥) flashes at a rate of 30 times per minute.
   - The UA mode is **TOCO**.
6. Access the Install Options screen and note the default TOCO reference value.
7. Press the monitor's front panel **UA Reference** pushbutton.
8. Verify the following on the monitor:
   - The UA value is referenced to the default value.
   - The recorder prints a continuous line at the default value on the bottom grid of the strip chart paper.
   - The recorder prints the messages MECG, TOCO, and UA REF on the strip chart paper.
9. Turn the simulator's **Manual Adjustment** knob to input an MECG signal of approximately 60 BPM. Verify the following on the monitor:
   - The MHR value is 60 BPM.
   - The MHR heartbeat indicator (♥) flashes at a rate of 60 times per minute.
   - The ECG "beep" volume can be heard from the rear panel speaker. The volume can be adjusted on the MHR/P Setup screen.
   - The recorder prints a continuous line at 60 BPM on the top grid of the strip chart paper.

Table 6-1. MECG Test Simulator Settings		
Section	Switch	Setting
FECG/MECG	Main	RATE
	Rate	MANUAL
	Mode	MECG
	QRS Amplitude	500 µV
	QRS Polarity	+
GENERAL	Pattern Memory	OFF
UA	Main	CMR
	Mode	TOCO

10. Repeat step 9 for each of the following rates: 30, 120, 210, and 240 BPM.
11. Change the simulator's **QRS Polarity** switch from + to –. Verify that the monitor does not skip any beats.
12. Set the simulator's **ECG Rate** switch to the RAMP setting. Verify that the monitor's MHR value counts between approximately 30 and 240 BPM and that the recorder prints a ramp between the same values. (Refer to Figure 6-2.)
13. Set the simulator's **ECG Rate** switch to the Δ15 position. Verify the following on the monitor:
    - The MHR value oscillates by 15 BPM.
    - The MHR heartbeat indicator (♥) flashes for each input signal.
    - The ECG "beep" is heard from the rear panel speaker; the volume can be adjusted on the MHR/P Setup screen.
    - The recorder prints an oscillation of 15 BPM between 115 and 130 BPM on the top grid of the strip chart paper. (Refer to Figure 6-3.)
14. Repeat step 13 for rate values of Δ22 and Δ27. The results should be the same except that the MHR value oscillates by either 22 or 27 BPM and the recorder prints an oscillation of 22 or 27 BPM. The top value is always at approximately 130 BPM. (Refer to Figure 6-3.)

15. Set the simulator's **ECG Rate** switch to the MANUAL position and the **Manual Adjustment** knob to the fully counterclockwise position. Disconnect the ECG simulator sub-cable from the monitor's y-adapter cable. Verify the following on the monitor:

    - The MHR/P value and mode are both blank.
    - The recorder stops printing maternal heart rate data on the strip chart paper.
    - The recorder prints the message CARDIO INOP on the center margin of the strip chart paper after approximately 30 seconds.

16. Set the simulator's **ECG Mode** switch to the OFF position.

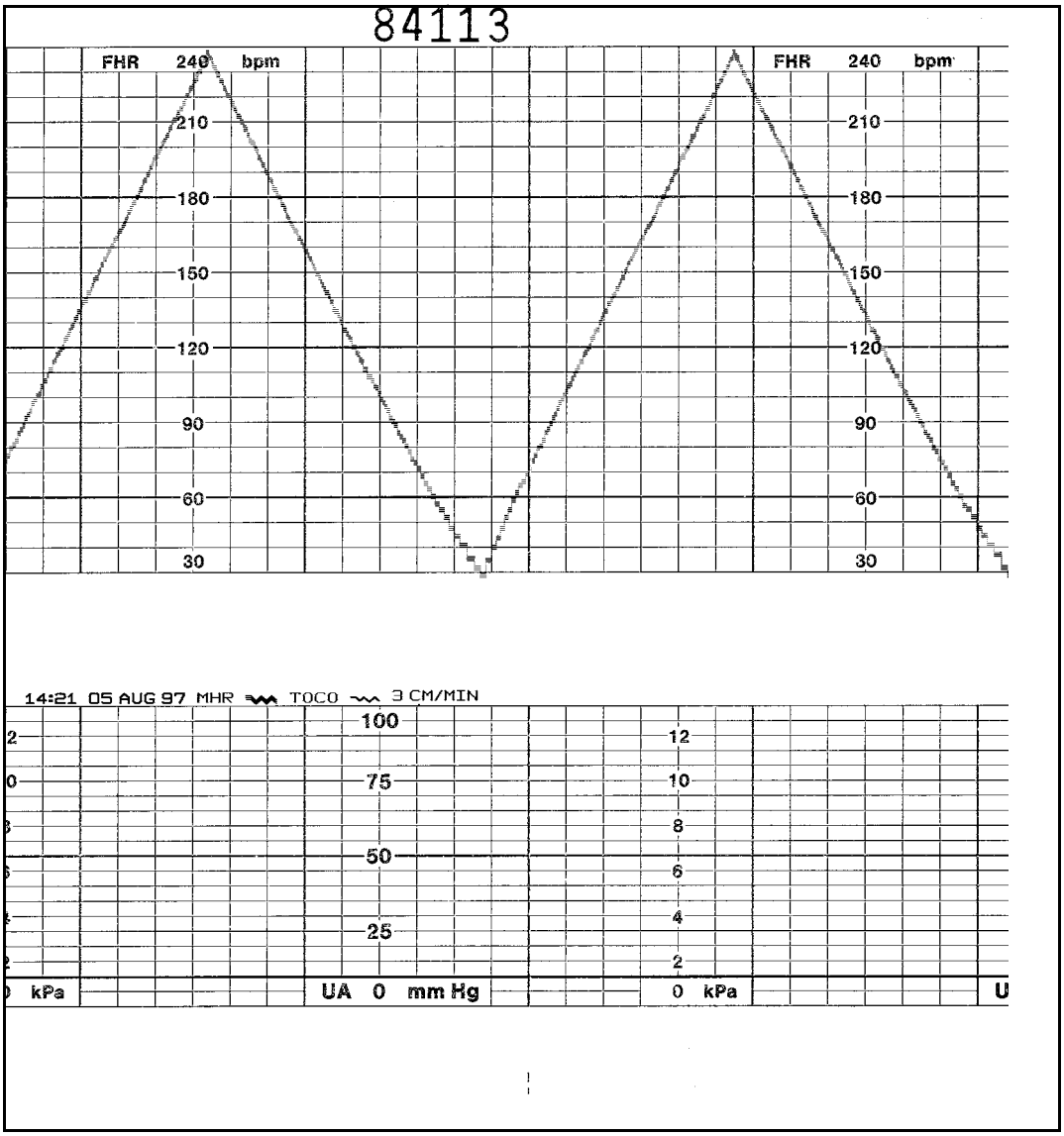


Figure 6-2. MECG Ramp

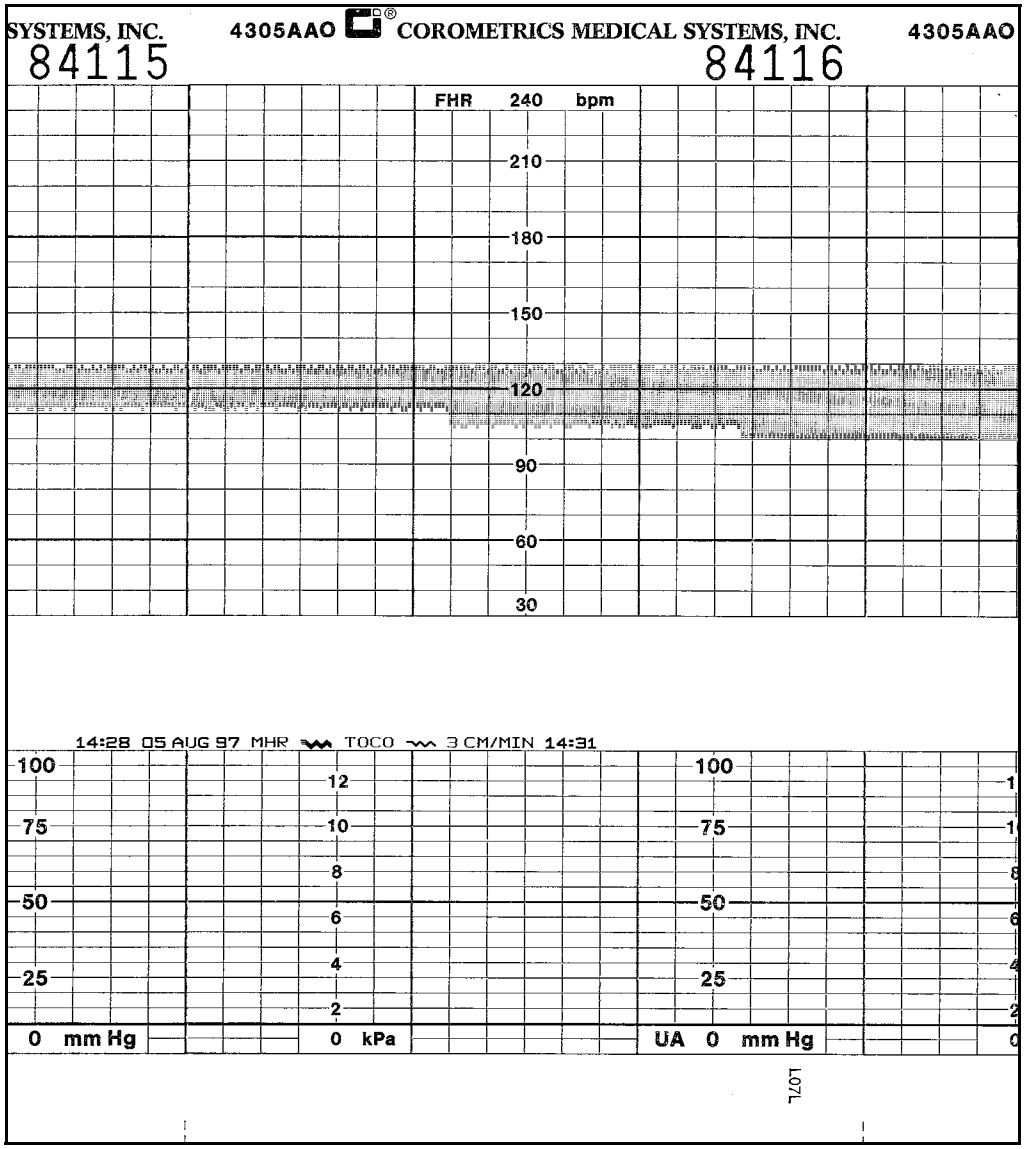


Figure 6-3. MECG Oscillation

FECG Test

This portion of the functional checkout procedure ensures the integrity of the FECG circuitry and the heart rate channel of the recorder.

1. Connect the simulator's ECG sub-cable to the **FECG** connector on the monitor adapter cable.
2. Connect the simulator's UA sub-cable to the **UA** receptacle on the monitor.
3. Set the switches on the Model 325 Input Simulator according to Table 6-1.
4. If not already on, depress the monitor's **Record** pushbutton.
5. Turn the simulator's **Manual Adjustment** knob fully counterclockwise and verify the following on the monitor's display:
   - The FHR1 value is 30 BPM.
   - The FHR1 mode is **FECG**.
   - The FHR1 heartbeat indicator (♥) flashes at a rate of 30 times per minute.
   - The UA mode is **TOCO**.
6. Depress and hold the monitor's **UA Reference** pushbutton and release when the UA value shows 10 relative units. Verify the following on the monitor:
   - The UA value is referenced to 10 relative units.
   - The recorder prints a continuous line at 10 relative units on the bottom grid of the strip chart paper.
   - The recorder prints the messages FECG, TOCO, and UA REF on the strip chart paper.
7. Turn the simulator's **Manual Adjustment** knob to input an FECG signal of approximately 120 BPM. Verify the following on the monitor:
   - The FHR1 value is 120 BPM.
   - FHR1 heartbeat indicator (♥) flashes at a rate of 120 times per minute.
   - The ECG "beep" volume of the rear panel speaker can be increased or decreased using the left pair of Volume pushbuttons. (Set the volume to the desired level.)
   - The recorder prints a continuous line at 120 BPM on the top grid of the strip chart paper.

Table 6-2. FECG Test Simulator Settings		
Section	Switch	Setting
FECG/MECG	Main	RATE
	Rate	MANUAL
	Mode	FECG
	QRS Amplitude	15 µV
	QRS Polarity	+
GENERAL	Pattern Memory	OFF
UA	Main	CMR
	Mode	TOCO

8. Repeat step 7 for each of the following rates: 30, 60, 210, and 240 BPM.
9. Change the simulator's **QRS Polarity** switch from + to –. Verify that the monitor does not skip any beats.
10. Set the simulator's **ECG Rate** switch to the RAMP setting. Verify that the monitor's FHR1 value counts between approximately 30 and 240 BPM and that the recorder prints a ramp between the same values. (Refer to Figure 6-4.)
11. Access the Install Options service screen and set ECG Artifact Elimination to OFF; then exit the service mode.
12. Set the simulator's **ECG Rate** switch to the Δ15 position. Verify the following on the monitor:
    - The FHR1 value oscillates by 15 BPM.
    - The FHR1 heartbeat indicator (♥) flashes for each input signal.
    - The ECG "beep" is heard from the rear panel speaker.
    - The recorder prints an oscillation of 15 BPM between 115 and 130 BPM on the top grid of the strip chart paper. (Refer to Figure 6-5.)
13. Repeat step 12 for rate values of Δ22 and Δ27. The results should be the same except that the FHR1 value oscillates by either 22 or 27 BPM and the recorder prints an oscillation of 22 or 27 BPM. The top value is always at approximately 130 BPM. (Refer to Figure 6-5.)
14. Access the monitor's Install Options service mode screen and set the ECG Artifact Elimination to ON.

15. Set the simulator's **ECG Rate** switch to the Δ15 position. Verify the following on the monitor:

    - The FHR1 value oscillates by 15 BPM.
    - The FHR1 heartbeat indicator (♥) flashes for each input signal.
    - The ECG "beep" is heard from the rear panel speaker.
    - The recorder prints an oscillation of 15 BPM between 115 and 130 BPM on the top grid of the strip chart paper. (Refer to Figure 6-5.)

16. Repeat step 15 for the rate value of Δ22. The result should be the same as step 15 except that the FHR1 value oscillates by 22 BPM and the recorder prints an oscillation of 22 BPM between the 108 and 130 BPM on the strip chart recorder paper.

17. Set the simulator's **ECG Rate** switch to the Δ27 position. Verify the following on the monitor:

    - The FHR1 value oscillates by 27 BPM.
    - The FHR1 heartbeat indicator (♥) flashes for each input signal.
    - The ECG "beep" is heard from the rear panel speaker.
    - The recorder does not print any oscillation.

18. Access the monitor's Install Options service mode screen and set the ECG Artifact Elimination back to OFF.

19. Set the simulator's **ECG Rate** switch to the MANUAL position and the **Manual Adjustment** knob to the fully counterclockwise position. Disconnect the ECG simulator sub-cable from the monitor's y-adapter cable. Verify the following on the monitor:

    - The FHR1 value and mode are both blank.
    - The recorder stops printing heart rate data on the strip chart paper.
    - The recorder prints the message CARDIO INOP on the center margin of the strip chart paper after approximately 30 seconds.

20. Set the simulator's **ECG Mode** switch to the OFF position.

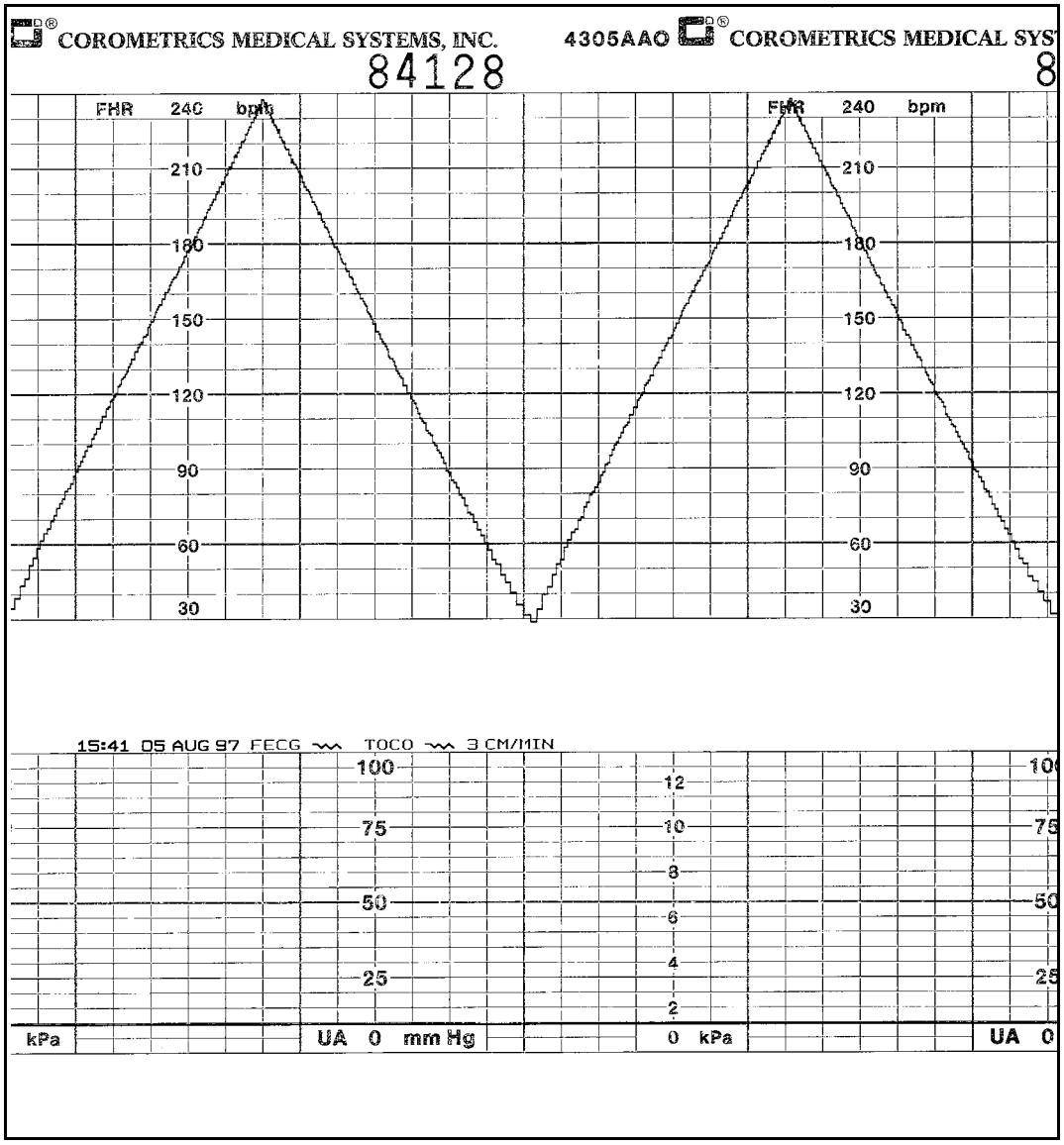


Figure 6-4. FECG Ramp

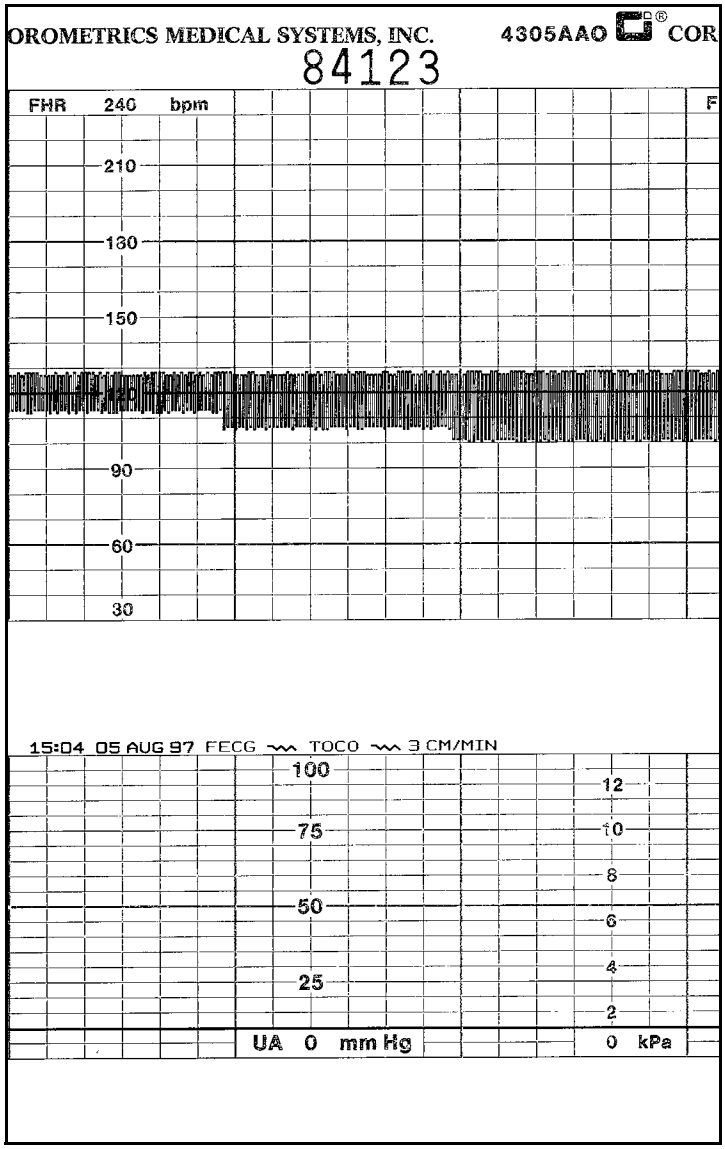


Figure 6-5. FECG Artifact Elimination

Ultrasound Test

This portion of the functional checkout procedure ensures the integrity of the ultrasound circuitry and the heart rate channel of the recorder.

1. Connect the simulator's US sub-cable to the **US** receptacle on the monitor.
2. Set the switches on the Model 325 Input Simulator according to Table 6-3.
3. If not already on, depress the monitor's **Record** pushbutton.
4. Turn the simulator's **Manual Adjustment** knob to input an ultrasound signal of approximately 120 BPM. Verify the following on the monitor:
   - The FHR1 value is 120 BPM.
   - The FHR1 mode is **US**.
   - The FHR1 heartbeat indicator (♥) flashes at a rate of 120 times per minute.
   - Ultrasound audio volume from the rear panel speaker can be increased or decreased using the left pair of **Volume** pushbuttons. (Set the volume to the desired level.)
   - The recorder prints a continuous line at 120 BPM on the top grid of the strip chart paper.
   - The recorder prints the message US on the center margin of the strip chart paper after approximately 20 seconds.
5. Use the simulator's **Manual Adjustment knob** to increase the heart rate value by less than 13 BPM from the 120 BPM baseline. Verify the following on the monitor:
   - The FHR1 value immediately reflects this new input rate.
   - The strip chart recorder immediately reflects this new input rate.
6. Use the simulator's **Manual Adjustment** knob to decrease the heart rate value by more than 13 BPM from the 120 BPM baseline. Verify the following on the monitor:
   - The FHR1 value immediately reflects this new input rate.
   - The strip chart recorder prints at the last input rate for an additional 3 seconds before blanking the heart rate data and printing a continuous line at the new input rate.
7. Set the simulator's **US Rate** switch to the RAMP position. Verify that the FHR1 value counts between approximately 50 and 210 BPM and that the recorder prints a ramp between the same values. (Refer to Figure 6-6.)

Table 6-3. Ultrasound Test Simulator Settings		
Section	Switch	Setting
US/FMD	Mode	US
	Signal Level	MED
	Rate	MANUAL
GENERAL	Pattern Memory	OFF
UA	Main	CMR
	Mode	TOCO

8. Place the simulator's **US Rate** switch in each of the individual rate settings (50, 60, 120, and 210 BPM). Verify the following on the monitor:
   - The FHR1 value reflects the simulator setting ± 1 BPM.
   - The FHR1 heartbeat indicator (♥) flashes at the simulator setting.
   - Ultrasound audio is heard coming from the rear panel speaker.
   - The recorder prints a continuous line at the respective value ± 3 BPM on the top grid of the strip chart paper.

9. Repeat step 4 through step 8 using the second ultrasound channel. (The mode will show **US2**.)

10. Place the simulator's **US Mode** switch in the OFF position. Verify the following on the monitor:
    - The FHR1 value and mode are both blank.
    - The recorder stops printing the fetal heart rate trace.
    - The recorder prints the message **CARDIO INOP** on the center margin of the strip chart paper after approximately 20 seconds.

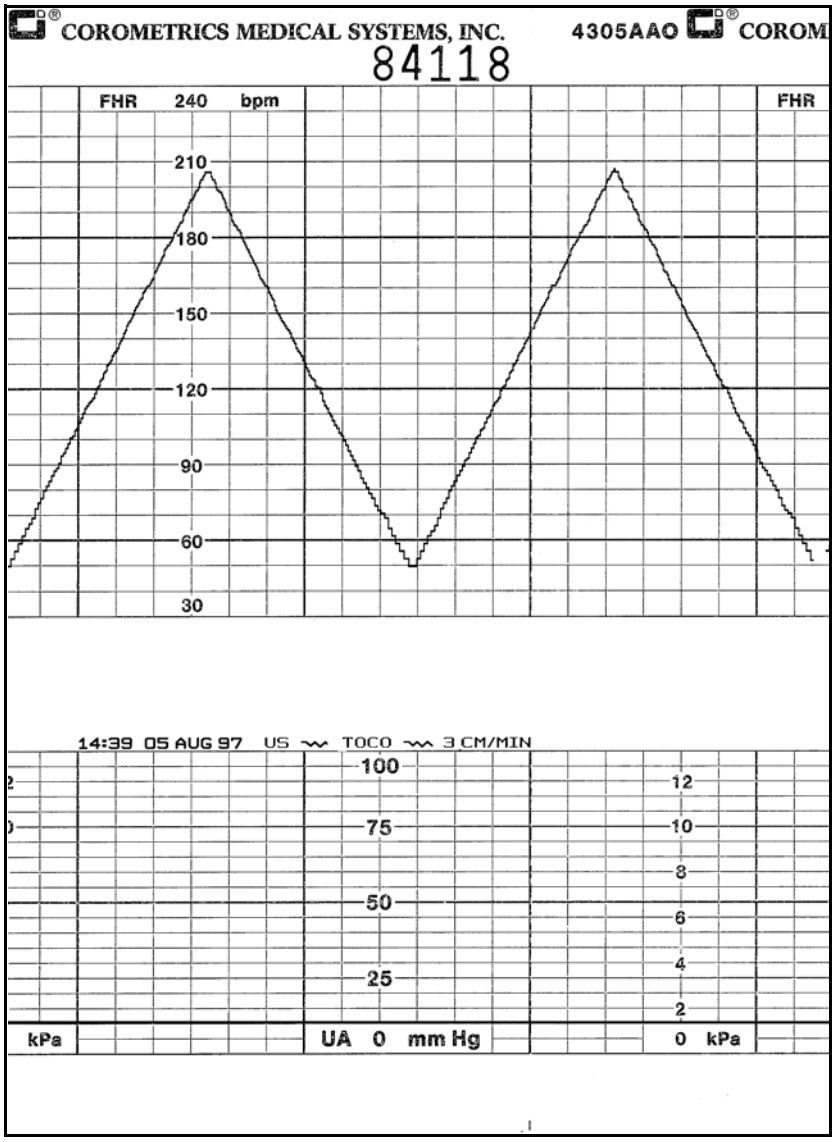


Figure 6-6. Ultrasound Ramp

Fetal Movement Detection Test

This portion of the functional checkout procedure ensures the integrity of the fetal movement detection circuitry and the heart rate channel of the recorder. (Refer to Figure 6-7.)

1. Connect the simulator's US sub-cable to the **US** receptacle on the monitor.
2. Set the switches on the Model 325 Input Simulator according to Table 6-4.
3. If not already on, depress the monitor's **Record** pushbutton.
4. Turn the simulator's **Manual Adjustment** knob to input an ultrasound signal of approximately 120 BPM. Verify the following on the monitor:
   - The FHR1 value is 120 BPM.
   - The FHR1 mode is **US**.
   - The **FMD** indication displays in-between the FHR1 and FHR2 mode title locations.
   - The FHR1 heartbeat indicator (♥) flashes at a rate of 120 times per minute.
   - Ultrasound audio volume from the rear panel speaker can be increased or decreased using the left pair of **Volume** pushbuttons. (Set the volume to the desired level.)
   - The recorder prints a continuous line at 120 BPM on the top grid of the strip chart paper.
   - Fetal movement markers - — are shown on for a duration of one second, then off for eight seconds, then on for one second, etc.
   - The recorder prints the messages US and FMD - — on the center margin of the strip chart paper after approximately 20 seconds.

Table 6-4. Fetal Movement Detection Test Simulator Settings

Section	Switch	Setting
US/FMD	Mode	US/FMD
	Signal Level	MED
	Rate	MANUAL
GENERAL	Pattern Memory	OFF
UA	Main	CMR
	Mode	TOCO

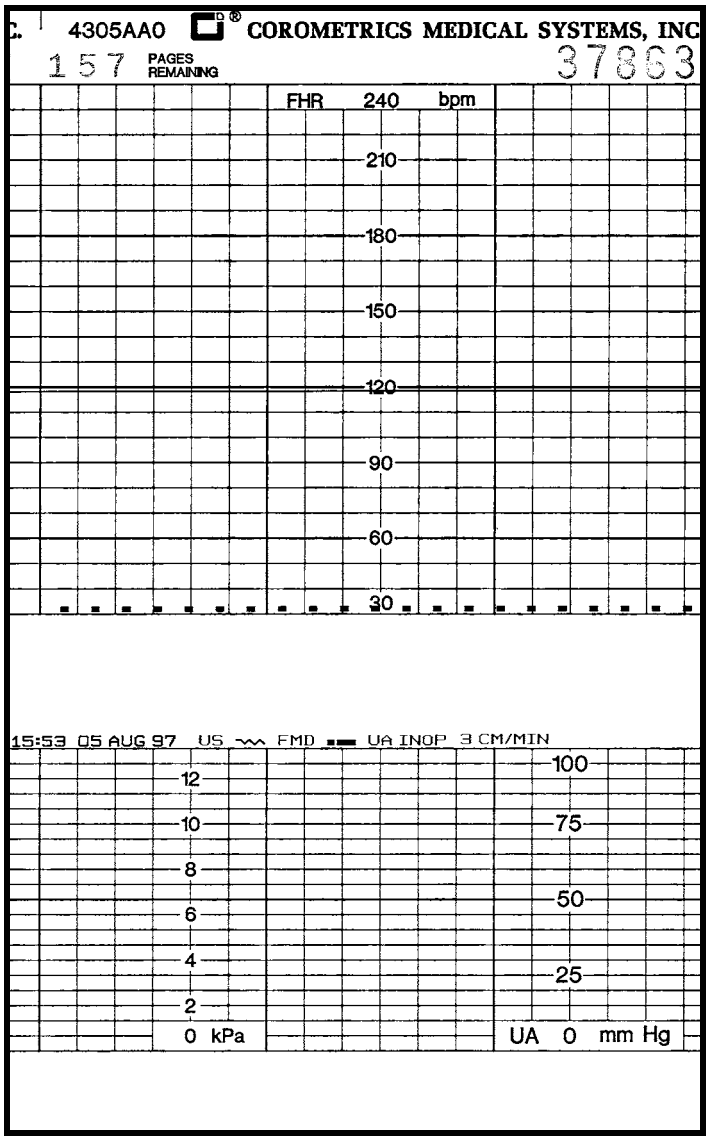


Figure 6-7. Fetal Movement Detection

Ultrasound Transducer Test

1. Inspect a Model 116/118/120 ultrasound transducer as follows:
   - Ensure there are no cracks around the transducer face.
   - Visibly assess the condition of the cable, strain relief, and connector pins.
2. Disconnect the simulator's ultrasound cable from the front panel of the 120 Series Monitor.
3. Connect the ultrasound transducer to either the **US** or **US2** input receptacle on the front panel of the monitor. Verify the following on the monitor:
   - The FHR1 value shows three steady dashes "– – –."
   - The FHR1 mode is **US**.
   - The recorder prints the message US on the center margin of the strip chart paper after approximately 20 seconds.
4. Gently rub each crystal of the ultrasound transducer rhythmically. (There are nine crystals. Eight are arranged around the circumference of the transducer; one is in the center.) Verify the following:
   - Good sensitivity is apparent.
   - The monitor's FHR1 value follows the input rate.
   - The recorder follows the input rate.
   - The FHR1 heartbeat indicator (♥) flashes for each input.
   - The FHR1 mode shows **US**.
   - Ultrasound audio is heard coming from the monitor's rear panel speaker.
5. Disconnect the ultrasound transducer from the front panel of the monitor. Verify the following on the monitor:
   - The FHR1 value, mode, and heartbeat indicator are all blank.
   - The recorder stops printing the fetal heart rate trace.
   - The recorder prints the message CARDIO INOP on the center margin of the strip chart paper after approximately 20 seconds.

Uterine Activity Test

This portion of the functional checkout procedure tests the uterine activity section of the 120 Series Monitor.

1. Set the switches on the Model 325 Simulator according to Table 6-5.
2. Connect the simulator's UA sub-cable to the **UA** receptacle on the monitor.
3. Access the Install Options service mode screen and note the default TOCO reference value. (The monitor is shipped from the factory with this value set at 10 relative units; however, your unit may have been custom configured.) Exit the service mode screens.
4. If not already on, depress the monitor's **Record** pushbutton.
5. Briefly press the monitor's **UA Reference** pushbutton. Verify the following on the monitor:
   - The UA value is the *default* setting.
   - The UA mode is **TOCO**.
   - The recorder prints a continuous line at the *default* value on the uterine activity channel of the strip chart paper.
   - The recorder prints the messages TOCO and UA REF on the strip chart paper.
6. Press and hold the **UA Reference** pushbutton on the monitor to cycle through the available selections for UA reference: 5, 10, 15, 20, or 25 relative units. Test each of these reference settings. Verify that the UA value is displayed accordingly and that the recorder prints a continuous line at the corresponding value on the uterine activity channel of the strip chart paper.
7. Place the simulator's **UA Level** switch at each of the level settings: 0, 10, 50, and 100 relative units. Verify that the UA value is displayed accordingly and that the recorder prints a continuous line at the corresponding value on the heart rate channel of the strip chart paper.
8. Place the simulator's **UA Mode** switch in the IUP position and the **UA Level** switch to 0 mmHg. Depress the monitor's **UA Reference** pushbutton and verify that the monitor and recorder reference to 0 mmHg. Verify the following on the monitor:
   - The UA value is 0 mmHg.
   - The UA mode is **IUP**.
   - The recorder prints a continuous line at 0 mmHg on the uterine activity channel of the strip chart paper.
   - The recorder prints the messages IUP and UA REF on the strip chart paper.

Table 6-5. Uterine Activity Test Simulator Settings		
Section	Switch	Setting
GENERAL	Pattern Memory	OFF
UA	Main	LEVEL
	Level	0 mmHg
	Mode	TOCO

9. Place the simulator's **UA Level** switch at each of the level settings: 0, 10, 50, and 100 mmHg. Verify that the UA value is displayed accordingly and that the recorder prints a continuous line at the corresponding value on the uterine activity channel of the strip chart paper.

10. Place the simulator's **UA Level** switch to the RAMP position. Verify that the UA value measures between approximately 0 and 100 mmHg and that the recorder prints a ramp between the same values. Refer to Figure 6-8.

11. Disconnect the Model 325 simulator's uterine activity sub-cable from the **UA** input receptacle on the front panel of the monitor. Verify the following on the monitor:

    - The UA value and mode are both blank.
    - The recorder stops printing the uterine activity trace.
    - The recorder prints the message UA INOP on the center margin of the strip chart paper after approximately 20 seconds.

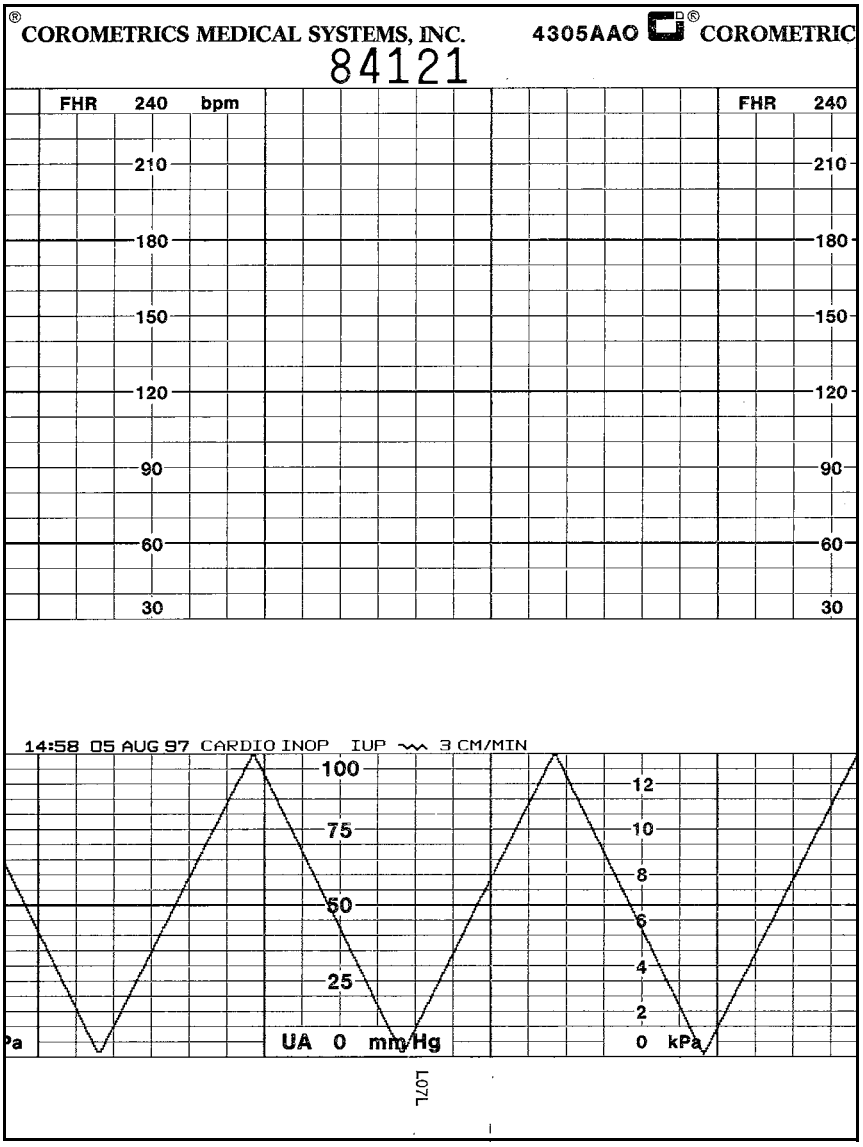


Figure 6-8. Uterine Activity Ramp

Tocotransducer Test

1. Inspect a Nautilus Tocotransducer as follows:

- Check for any cracks or contaminants on the tocotransducer especially on the diaphragm located on the bottom of the tocotransducer.
- Visibly assess the condition of the cable, strain relief, and connector pins.

12. Connect the tocotransducer to the **UA** input receptacle on the front panel of the 120 Series Monitor.

> **IMPORTANT**
> TRIMLINE TOCOTRANSDUCER—If you are using an older Trimline tocotransducer for this test, be advised of the following. If the monitor is *on* when you connect or re-connect a Trimline Tocotransducer to the **UA** connector, you ***must*** wait at least 10 seconds before pressing the **UA Reference** pushbutton. If the monitor is *off*, you ***must*** wait at least 10 seconds from the time the monitor is powered *on*.

13. Access the Install Options service mode screen and note the default TOCO reference setting.

14. Momentarily depress the monitor's **UA Reference pushbutton**. Verify the following:

- The UA value shows the *default* setting.
- The UA mode shows **TOCO**.
- The recorder prints the messages UA REF and TOCO on the strip chart paper.

15. Apply gentle pressure to the tocotransducer diaphragm and verify that the UA value responds to the pressure input. Increasing force should produce an increasing value and vice versa.

16. Remove the tocotransducer from the monitor's **UA** input receptacle. Verify the following on the monitor:

- The UA value and mode are both blank.
- The recorder stops printing the uterine activity trace.
- The recorder prints the message UA INOP on the center margin of the strip chart paper after approximately 20 seconds.

Strain Gauge Transducer Test

1. Inspect a Model 116/118/120 strain gauge as follows:
   - Unscrew the plastic dome from the transducer and check for any cracks or contaminants on the transducer.
   - Visibly assess the condition of the cable, strain relief, and the connector pins.

2. Connect the strain gauge to the **UA** input receptacle on the front panel of the 120 Series Monitor. Verify the following on the monitor:
   - The UA value may read negative numbers indicating baseline pressure is off scale. In this case, the recorder prints the message BASELINE PRESSURE OFF SCALE on the center margin of the strip chart paper.
   - The UA mode is **IUP** for intrauterine pressure.
   - The recorder prints the message IUP on the center margin of the strip chart paper after approximately 20 seconds.

3. Depress the monitor's **UA Reference** pushbutton and verify the following on the monitor:
   - The UA value is 0 mmHg.
   - The recorder prints a continuous line at 0 mmHg on the strip chart paper.
   - The recorder prints the message UA REF on the bottom two lines of the top grid of the strip chart paper.

4. Apply gentle pressure on the strain gauge diaphragm and verify that the display and recorder respond to the input. Increasing force should produce an increasing value and vice versa.

5. Disconnect the strain gauge from the front panel of the monitor. Verify the following on the monitor:
   - The UA value and mode are both blank.
   - The recorder stops printing the uterine activity trace.
   - The recorder prints the message UA INOP on the center margin of the strip chart paper after approximately 20 seconds.

Pattern Memory Test

The pattern memory of the simulator can be used to test any of the following mode combinations of the monitor.

• FECG/TOCO	• US2/IUP
• FECG/IUP	• FECG/US/TOCO
• MECG/TOCO	• FECG/US/IUP
• MECG/IUP	• FECG/US2/TOCO
• US/TOCO	• FECG/US2/IUP
• US/IUP	• US/TOCO/MECG
• US/FMD/TOCO	• US/IUP/MECG
• US/FMD/IUP	• US2/TOCO/MECG
• US2/TOCO	• US2/IUP/MECG

NOTE: US/US2 cannot be tested simultaneously unless two Model 325 Simulators or two Model 116/118/120 ultrasound transducers are used. Do not attempt to test dual ultrasound using one Model 325 Simulator and one ultrasound transducer or a conflict between enable lines will occur.

NOTE: FECG/MECG cannot be tested simultaneously unless two Model 325 Simulators are used.

NOTE: Although dual heart rate can be verified using the pattern memory, an additional procedure is given in this functional checkout procedure.

To check any of the mode combinations listed above:

1. Connect the appropriate simulator sub-cables to the corresponding receptacles on the monitor.
2. Enable the modes on the simulator.
3. Set the simulator's **Pattern Memory** switch to the ON position.
4. If not already on, depress the monitor's **Record** pushbutton.
5. Verify the following on the monitor:
   - ◆ Each heart rate area (FHR1, FHR2, and/or MECG) responds accordingly for value, mode, and heartbeat indicator.
   - ◆ The UA area responds accordingly for value and mode.
   - ◆ The recorder responds appropriately in both trending and message information.

NOTE: Refer to the *Model 325 Simulator Product Manual* for illustrations of the patterns to be expected on the monitor.

Dual Heart Rate Test (Non-Pattern)

FECG/US Modes

1. Connect the FECG/MECG adapter cable to the **FECG/MECG** connector on the 120 Series Monitor.
2. Connect the Model 325 simulator's ECG sub-cable to the **FECG** input on the monitor's adapter cable.
3. Connect the simulator's US sub-cable to the monitor's **US** input receptacle.
4. Set the switches on the Model 325 Simulator according to Table 6-6.
5. If not already on, depress the monitor's **Record** pushbutton.
6. Verify the following on the monitor:
   - The FHR1 value reads 120 BPM.
   - The FHR1 mode reads **FECG**.
   - The FHR1 heartbeat indicator (♥) flashes at a rate of 120 times per minute.
   - The FHR2 value varies between approximately 50 and 210 BPM.
   - The FHR2 mode reads **US**.
   - The FHR2 heartbeat indicator (♥) flashes at a rate consistent with the value.
   - The recorder prints the messages FECG and US on the center margin of the strip chart paper.
   - The recorder prints a continuous plain black line (¬⩘⩘) on the 120 BPM mark on the heart rate channel of the strip chart paper. (Refer to Figure 6-9.)
   - The recorder prints a bold black ramp trace (¬⩙⩙) between 50 and 210 BPM on the heart rate channel of the strip chart paper. (Refer to Figure 6-9.)

Table 6-6. Dual Heart Rate Test (Non-Pattern) Simulator Settings		
Section	Switch	Setting
FECG/MECG	Main	RATE
	Rate	120 BPM
	Mode	FECG
	QRS Amplitude	50 µV
	QRS Polarity	+
ULTRASOUND/FMD	Mode	US
	Level	MED
	Rate	RAMP
GENERAL	Pattern Memory	OFF

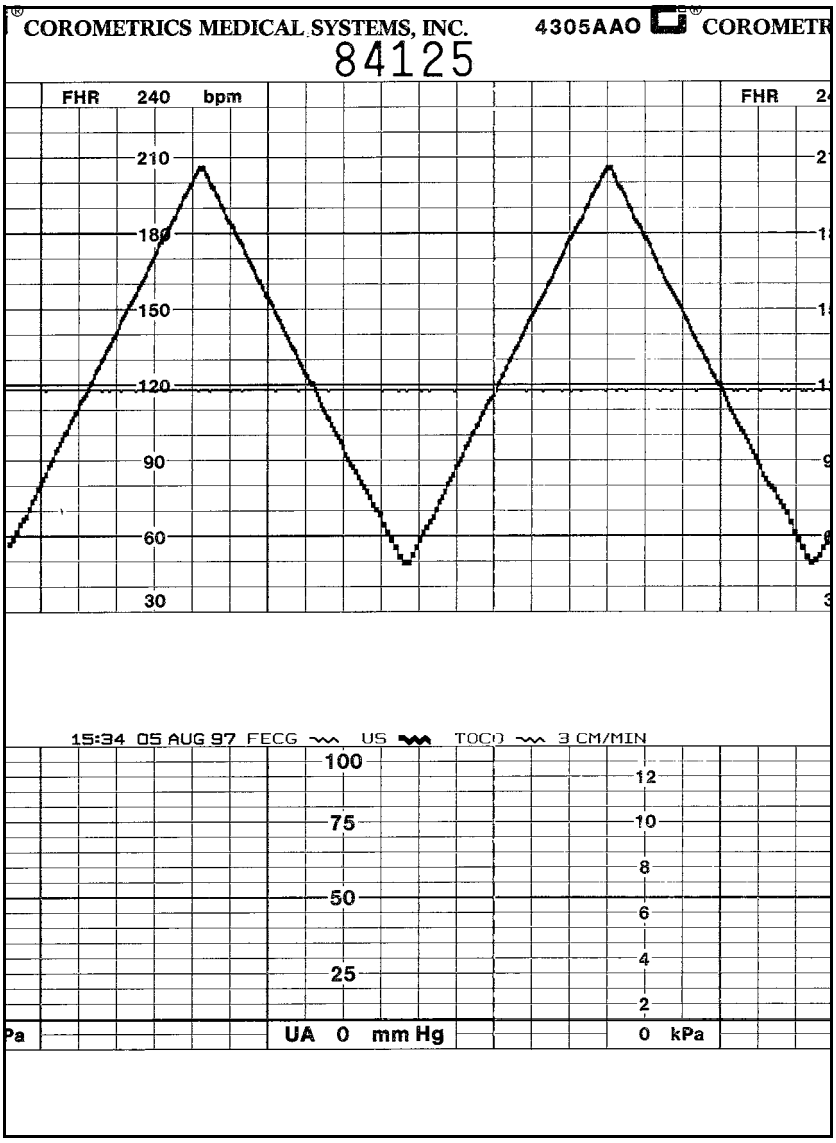


Figure 6-9. Dual Heart Rate, FECG and US

Dual Ultrasound Modes

As stated previously, the dual ultrasound mode of the 120 Series Monitor cannot be tested unless two Model 325 Simulators are used or two Model 116/118/120 ultrasound transducers. ***Do not*** attempt to test dual ultrasound using one Model 325 Simulator and one ultrasound transducer. This procedure details using two transducers since it is more practical for a test site.

1. If not already on, depress the monitor's **Record** pushbutton.
2. Plug one ultrasound transducer into the monitor's **US** input receptacle and the other into the monitor's **US2** receptacle. Verify the following on the monitor:
   - The FHR1 mode shows **US**.
   - The FHR2 mode shows **US2**.
   - The FHR1 value shows three steady dashes "– – –."
   - The FHR2 value shows three steady dashes "– – –."
   - The recorder prints the messages US and US2 on the center margin of the strip chart paper.
3. Use your finger to rub the face of the ultrasound transducer connected to the monitor's **US** input receptacle; try to maintain a steady rate and verify the following on the monitor:
   - The FHR1 value responds to the rubbing.
   - The FHR1 heartbeat indicator (♥) responds to the input.
   - The recorder prints the heart rate tracing corresponding to the rate and the trace is plain black (¬√√^).
4. Use your finger to rub the face of the ultrasound transducer connected to the monitor's **US2** input receptacle; try to maintain a steady rate and verify the following on the monitor:
   - The FHR2 value responds to the rubbing.
   - The FHR2 heartbeat indicator (♥) responds to the input.
   - The recorder prints the heart rate tracing corresponding to the rate and the trace is plain black (¬√√^).

Alarm Test

This portion of the test ensures the integrity of the audio alarms and tests the alarm limit software.

1. Connect the FECG/MECG adapter cable to the **FECG/MECG** input receptacle on the 120 Series Monitor.
2. Connect the Model 325 Simulator's ECG sub-cable to the adapter's **MECG** input.
3. Use the Trim Knob control to access the MHR/P Setup screen.
4. Set the MHR/P source to MECG.
5. Set the MHR/P high alarm limit value to 120 bpm.
6. Set the MHR/P low alarm limit value to 60 bpm.
7. Set the MHR/P audio alarm to ON.
8. Set the alarm volume to a level you can easily hear.
9. Exit the MHR/P Setup screen.
10. Access the Master Alarm Setup screen.
11. Set the re-alarm time to 30 seconds.
12. Exit the setup screen.
13. Set the switches on the Model 305 Input Simulator according to Table 6-7.
14. Using the simulator's **Manual Adjustment** knob, input an MECG signal of 119 bpm as indicated on the monitor. Verify that there is no alarm tone sounding from the monitor's rear panel speaker.
15. Using the simulator's **Manual Adjustment** knob, increase the MECG rate to 120 bpm. Again, verify that there is no alarm tone sounding from the rear panel speaker.
16. Using the simulator's **Manual Adjustment** knob, increase the MECG rate to 121 bpm. Verify the following on the monitor:

    The following alarm tone is emitted from the rear panel speaker: alternating high/low tones until the alarm condition is removed (following steps.)

    The MECG value flashes.
17. Depress the monitor's front panel **Alarm Silence** pushbutton and verify the following:

    - The alarm tone is silenced.
    - The MECG value no longer flashes.

Table 6-7. Alarm Test Simulator Settings		
Section	Switch	Setting
FECG/MECG	Main	RATE
	Rate	MANUAL
	Mode	MECG
	QRS Amplitude	500 µV
	QRS Polarity	+
GENERAL	Pattern Memory	OFF

18. Wait 30 seconds and verify the following:
    - The alarm tone is once again emitted from the rear panel speaker.
    - The MECG value flashes again.
19. Depress the monitor's front panel **Alarm Silence** pushbutton again.
20. Use the simulator's **Manual Adjustment** knob to decrease the MECG rate to 120 bpm. Verify the following on the monitor:
    - The alarm tone is silenced.
    - The MECG value no longer flashes.
    - After 10 seconds, the two above conditions are still true.
21. Using the simulator's **Manual Adjustment** knob, input an MECG signal of 61 bpm. Verify that there is no alarm tone sounding from the rear panel speaker.
22. Using the simulator's **Manual Adjustment** knob, decrease the MECG rate to 60 bpm. Again, verify that there is no alarm tone sounding from the rear panel speaker.
23. Using the simulator's **Manual Adjustmen**t knob, decrease the MECG rate to 59 bpm. Verify the following on the monitor:
    - The alarm tone is emitted from the monitor's rear panel speaker.
    - The MECG value flashes.
24. Depress the monitor's front panel **Alarm Silence** pushbutton and verify the following:
    - The alarm tone is silenced.
    - The MECG value no longer flashes.

25. Wait ten seconds and verify the following:
    - The alarm tone is once again emitted from the rear panel speaker.
    - The MECG value flashes again.
26. Depress the monitor's front panel **Alarm Silence** pushbutton again.
27. Use the simulator's **Manual Adjustment** knob to decrease the MECG signal to 60 bpm. Verify the following on the monitor:
    - The alarm tone is silenced.
    - The MECG value no longer flashes.
    - After 10 seconds, the two above conditions are still true.

$MSpO_2$ Test

1. Access the 120 Monitor's $MSpO_2$ Setup window and configure as follows:
   - (Nellcor only) Response Time = Normal
   - (Masimo only) Sensitivity = Normal
   - (Masimo only) Averaging = 8
   - Print Interval = 2 minutes
   - Trace = On
2. Access the monitor's $MSpO_2$ Setup window and set the $MSpO_2$ Scale to AUTO.
3. Access the monitor's MHR/P Setup window and configure as follows:
   - MHR/P Source = $MSpO_2$
   - MHR/P Trace = On
4. If your monitor has Nellcor technology installed, connect one end of the Nellcor cable to a Nellcor pulse oximetry simulator; connect the other end to the monitor's $MSpO_2$ connector.
5. If your monitor has Masimo technology installed, connect one end of the Masimo cable to a Masimo pulse oximetry simulator; connect the other end to the monitor's $MSpO_2$ connector.
6. Allow the monitor a few seconds to obtain a steady reading.
7. Turn on the recorder and allow data to collect for at least five minutes.Verify the following on the monitor:
   - The correct waveform appears on the display.
   - The %$MSpO_2$ display value is 81% ± 2%
   - The $MSpO_2$ pulse amplitude indicator shows a fluctuating bar graph.
   - The MHR/P display mode is PULSE.
   - The MHR/P display value is 112 BPM ± 3 BPM
   - The MHR/P trend plots in the top grid at 112 BPM ± 3 BPM.
   - The $MSpO_2$ scale grid marks stamp on the paper.
   - The message $MSpO_2$% stamps in the annotation line on the strip chart paper.
   - A diamond ◊ (with %$MSpO_2$ and MHR/P vital signs) stamps in the annotation area on the strip chart paper at two-minute intervals.

NBP Test

Refer to "Accessing the Diagnostic Control Screen" on page 9-6 for information about a manometer pressure check and pneumatic pressure check.

Preventative Maintenance Inspection Report

Customer_____Customer Number_____ Date _____

FE_____ FE ID _____Call Number _____

Equipment Serial Number _____ Software Revision CPU _____ DSP: _____

Configuration

Model 126_____ Model 128 _____ Fetal Movement Detection (FMD) _____

Model 129 _____ Communication Option _____ FSp0$_2$_____

Tools Required

• Digital Multimeter	• Static-Free Work Surface
• Plastic Alignment Tool	• Mild Soap/Water Solution
• Standard Hand Tools	• Isopropyl Alcohol
• Leakage Current Tester (E278-06 or equivalent)	• Baum Manometer (for Models 128/128F/129/129F only)
• Leg plate (2608DAO-1)	• FECG/MECG Adapter (1442AAO)
• Model 325 Simulator with Cables	• Baum Test Connector (for Models 128/128F/129/129F only)
• ESD Mat and Wristband	• 120 Series Operator's Manual (2015589-001)
	• Assembly Leakage Cable

Visual Inspection

Inspect the following for excess wear and/or signs of damage

☐ AC Power Cord	☐ MSpO$_2$ Cable/Sensor (Models 128/128F/129/129F only)
☐ Ultrasound Transducer	☐ Receptacles
☐ MECG Patient Cable (Model 129F only)	☐ Interconnect Cables
☐ Leg Plate	☐ Correct Fuses
☐ Tocotransducer	☐ Chassis
☐ IUPC Transducer	☐ 2116 Keyboard (if used)
☐ IUPC Intermediate Cable	☐ Front Panel Switches
☐ Remote Marker	☐ Internal Harnesses/Connectors
☐ NBP Hose/Cuff (Models 128/128F/129/129F only)	☐ Power Supply Fan

NOTE: GE Medical Systems *Information Technologies* hereby gives its customers permission to reproduce pages 6-36 through 6-39 of this manual for the purpose of servicing the equipment.

Inspection Checklist

Page	Description	Complete	Max	Actual	Pass	Fail	N/A
Cleaning							
page 9-2	Clean the monitor exterior.						
	Clean the monitor interior using a hand-held vacuum.						
page 10-4	Clean the recorder printhead.						
page 9-3	Clean the monitor accessories (tocos, transducers, cables)						
page 9-4	Clean the monitor accessories (cuffs, hoses)						
Calibration							
Page	Description	Complete	Max	Actual	Pass	Fail	N/A
page 7-3	Verify the power supply voltages on the Main Board.						
page 7-4	Verify the power supply voltages on the Isolated Power Supply Board.						
page 10-6	Adjust the printhead.						
page 10-12	Adjust the photosensors on the Recorder Board.						
Electrical Safety Tests							
Page	Description	Complete	Max	Actual	Pass	Fail	N/A
page 9-12	AC Line (120 V ↑ 10%)		(<300 mΩ)				
page 9-12	Ground Impedance (<300 mΩ) Lead to rear panel ground lug (<300 mΩ) Lead to top cover bezel screw (<300 mΩ)		(<300 mΩ)				
page 9-13	Unit to primary leakage		(<300µA)				
page 9-14	Patient-to-Ground leakage for ECG		(<50µA)				
page 9-15	Patient-to-Line leakage for ECG		(<50µA)				
page 9-16	Patient-to-Ground leakage for IUP		(<50µA)				
page 9-17	Patient-to-line leakage for IUP		(<50µA)				

Page	Description	Complete	Max	Actual	Pass	Fail	N/A
page 9-18	Patient-to-Ground leakage for MSp0$_2$		(<50µA)				
page 9-19	Patient-to-Line leakage for MSp0$_2$		(<50µA)				
page 9-20	Patient-to-Ground leakage for FSp0$_2$		(<50µA)				
page 9-21	Patient-to-Line leakage for FSp0$_2$		(<50µA)				
page 9-22	Patient-to-Ground leakage for US		(<50µA)				
page 9-23	Patient-to-Line leakage for US		(<50µA)				
page 9-24	Patient-to-Ground leakage for US2		(<50µA)				
page 9-25	Patient-to-Line leakage for US2		(<50µA)				
page 9-25	Ground Continuity						
Perform Functional Checkout in Chapters 6 & 8 of this Manual							
Page	Description	**Complete**	**Max**	**Actual**	**Pass**	**Fail**	**N/A**
page 8-3	Monitor Selt-Test						
page 6-5	Front Panel Button Test						
page 6-7	MECG Test						
page 6-11	FECG Test						
	Leg Plate Test (Follow Manufacturer's Directions)						
page 6-16	Ultrasound Test						
page 6-19	Fetal Movement Detection Test						
page 6-16	Ultrasound Test						
page 6-22	Uterine Activity Test						
page 6-25	Tocotransducer Test						
page 6-26	Strain Gauge Test (if used)						

Page	Description	Complete	Max	Actual	Pass	Fail	N/A
page 6-27	Pattern Memory Test						
page 6-28	Dual Heart Rate Test						
page 6-31	Dual Ultra Sound Modes						
page 6-32	Alarm Test						
page 6-35	MSp0$_2$ Test						
page 9-9	Manometer Pressure Check (annual)		See Table 9-1 on page 9-10				
page 9-11	Pneumatic Pressure Check (annual)						
page 8-12	Recorder Calibration Test						
page 8-17	Corolan Address Check						
	Remote Marker (if used, refer to instructions that accompanied this accessory)						
	2116 Keyboard (if used, refer to instructions that accompanied this accessory)						

For your notes

Chapter 7

Calibration

This section of the manual provides a calibration procedure which allows authorized service personnel to perform an instrument alignment using a minimum of test equipment. This procedure is not intended to replace a complete instrument checkout and alignment as performed at the GE factory. It should be considered a performance check and troubleshooting guide to be used in conjunction with other information supplied throughout this service manual. It is important to mention, this section of the manual is not intended as a substitute for proper professional training, or familiarity with the 120 Series Monitor. Only qualified service personnel should attempt servicing the 120 Series Monitor.

This chapter contains the following information:

Before You Begin 7-2
Power Supply Voltages—Verification 7-3
Recorder Photosensor Calibration 7-5
Display Check 7-7
Trimline Tocotransducer Calibration 7-20
Nautilus Tocotransducer Calibration 7-23
Maternal SpO2 Calibration 7-28

Before You Begin

General

Refer to the associated assembly drawings in "Chapter 15, Block Diagrams", for the location of adjustments and test points referred to in this section. The board assembly drawing numbers are given for each board in this section. The electronic calibration procedure outlined in this section necessitates removal of the monitor's top cover. Also, the following equipment will be needed in order to carry out the procedural steps.

- Digital Voltmeter, Fluke 8020A or equivalent
- Plastic Alignment Tool
- Oscilloscope

Handling Precautions

The following guidelines should be followed when handling *circuit boards or assemblies containing circuit boards*. Following these procedures helps resist damage that can be caused by static electricity.

- Discharge any static charge you may have built up before handling parts.
- Wear a grounded, anti-static wristband at all times.
- Use a static-free work surface.
- Store items in anti-static bags or boxes.
- Do not remove items from anti-static containers until needed.

Power Supply Voltages—Verification

There are no adjustments for the power supply voltages; however, you can verify them as follows:

Main Board Power Supply Voltages

Using a digital voltmeter, measure and verify the power supply voltages using the J14 connector on the Main Board. Refer to Table 7-1.

NOTE: There are no adjustments for these voltages.

Table 7-1. Main Board Power Supply Voltages

J14 ON 11619	Signal Name	Voltage Level
Pin 1	+12EL	+12 Vdc ± 0.5 Vdc
Pin 2	+20I	+20 Vdc ± 0.5 Vdc
Pin 3	+15BP	+15 Vdc ± 0.5 Vdc
Pin 4	–15V	–15 Vdc ± 0.5 Vdc
Pin 5	+15V	+15 Vdc ± 0.5 Vdc
Pin 6	+12A	+12 Vdc ± 0.5 Vdc
Pin 7	+5V	+5 Vdc ± 0.5 Vdc
Pin 8	GND	—
Pin 9	No Connection	—
Pin 10	Keying	—

Isolated Power Supply Board Voltages

This procedure performs an adjustment on the Isolated Power Supply Board.

1. Connect the positive lead of a digital voltmeter to TP7 on the Isolated Power Supply Board.
2. Connect the negative lead to TP8 (isolated ground).
3. Adjust R7 for a reading of +16.50 Vdc ± 0.15 Vdc on the digital voltmeter.

Isolated FECG/UA Board Voltages

This procedure performs an adjustment on the FECG/UA Board.

1. Connect the positive lead of a digital voltmeter to TP1 on the FECG/UA Board.
2. Connect the negative lead to TP2 or TP3 (isolated ground).
3. Adjust R28 for a reading of +4.00 Vdc ± 0.01 Vdc.

Recorder Photosensor Calibration

Adjusting the Paper-Low Photosensor

1. Load paper in the recorder. Ensure that there are *no* black squares showing to indicate a paper-low condition.
2. Press the **Record** button to turn on the recorder. Allow the paper to advance for a few seconds in order to tension the paper.
3. Turn off the recorder.
4. Using a digital voltmeter, connect the positive lead to J9 (pin 4) on the Recorder Board; connect the negative lead to J9 (pin 2).
5. Adjust R31 for a reading of +150 mVdc ± 2 mVdc on the digital voltmeter.

NOTE: If you open and then close the recorder door, the reading may vary 5–10 mV, due to the loss of tension in the paper. This is acceptable and you do not need to re-adjust.

6. Open the door and verify that the reading on the digital voltmeter is greater than +4.75 Vdc.
7. Re-load the paper so that black squares show on the surface (i.e. the last several sheets of a pack).
8. Turn on the recorder.
9. The value on the digital voltmeter should go up and down as the paper surface alternates between black and white. Verify that the maximum value is greater than or equal to 2.0 Vdc.
10. Turn off the recorder.

Adjusting the Paper-Out Photosensor

1. Load paper in the recorder. Ensure that there are *no* black squares showing to indicate a paper-low condition.
2. Press the **Record** button to turn on the recorder. Allow the paper to advance for a few seconds in order to tension the paper.
3. Turn off the recorder.
4. Using a digital voltmeter, connect the positive lead to J9 (pin 3) on the Recorder Board; connect the negative lead to J9 (pin 2).
5. Adjust R29 for a reading of +150 mVdc ± 2 mVdc on the digital voltmeter.

NOTE: If you open and then close the recorder door, the reading may vary 5–10 mV, due to the loss of tension in the paper. This is acceptable and you do not need to re-adjust.

6. Open the door and verify that the reading on the digital voltmeter is greater than +4.75 Vdc.
7. Turn off the recorder.

Adjusting the Paper-Loading Sensor

1. Load paper in the recorder. Ensure that there are *no* black squares showing to indicate a paper-low condition. You must load at least nine sheets of paper.
2. Using a digital voltmeter, connect the positive lead to J9 (pin 6) on the Recorder Board; connect the negative lead to J9 (pin 2).
3. Adjust R41 for a reading of +190 mVdc ± 5 mVdc on the digital voltmeter.
4. Although a factory-only fixture is required for this step, you may wish to try it by estimating the required distance. Load paper *backwards* with the white surface 0.380 in away from the paper tray. This creates a paper-loading error condition. Verify that the voltage at J9 (pin 6) on the Recorder Board is at least 2.70 Vdc.

Display Check

The 120 Series Display is manufactured by Planar Systems, Inc. All adjustments are made at the Planar factory. There is no calibration or replacement procedure for either the Display Driver Board or the Power Controller Unit. Contact your GE Service Representative for information about repair/exchange of the entire display assembly.

WARNING

HIGH VOLTAGE—The 120 Series Monitor display generates potentially dangerous voltages capable of causing personal injury (high voltage pulses up to 195 VAC). Do not touch the display electronics during operation!

CAUTION

ELECTROSTATIC DISCHARGE—The 120 Series Monitor display uses CMOS and MOS-FET components. These components are electrostatic sensitive. Unpack, assemble, and examine this assembly in a static-controlled area only. When shipping, use packing materials designed for protection of electrostatic-sensitive components.

Checking a 3” x 3.75” Display

Older monitors contain a 3-inch x 3.75-inch display. This display is no longer available from Planar and must be replaced with a larger display (and new front bezel).

In troubleshooting, the following methods can be employed to determine whether a problem exists with the display assembly, the 120 Series Monitor DSP Board, or the interconnect cable.

Verifying the DSP Board Operation (3”x 3.75” Display)

1. Turn off the 120 Series Monitor.
2. Remove the nine screws which secure the monitor top cover. Four screws are located on the bottom of the monitor and five screws are located in the back.
3. Remove the cover by sliding it toward the rear of the monitor.
4. Unplug the display interconnect cable from J5 on the DSP Board.
5. Turn on the 120 Series Monitor.
6. Using a digital voltmeter, attach the negative lead to J5 (pin 16), ground, on the DSP Board. Attach the positive lead to J5 (pin 1). Verify a reading of +12 Vdc ± 1.2 Vdc. This checks for the presence of the Vcc2 signal.
7. Attach the positive lead to J4 (pin 3) on the DSP Board. Leave the negative lead attached to ground. Verify a reading of +5 Vdc ± 0.25 Vdc. This checks for the presence of the Vcc1 signal.
8. Using an oscilloscope, attach the negative lead to J5 (pin 16), ground, on the DSP Board. Attach the positive lead to J5 (pin 11). Verify the output of a periodic waveform. This checks for the presence of the HS signal.
9. Attach the positive lead to J5 (pin 9) on the DSP Board. Leave the negative lead attached to ground. Verify the output of a periodic waveform. This checks for the presence of the VS signal.
10. Attach the positive lead to J5 (pin 13). Leave the negative lead attached to ground. Verify the output of a period waveform. This checks for the presence of the VCLK signal.
11. If you suspect that the DSP Board is not supplying the correct voltage or one of the video signals is missing and you have another properly functioning 120 Series Monitor, substitute the DSP Board and check for proper operation. Contact your Corometrics Service Representative for information about repair/ exchange of the DSP Board.
12. If you suspect that the interconnect cable is not working properly, refer to “Chapter 14, Replacement Parts” for parts information. Your GE Service Representative for part ordering information.

13. If you suspect that either the Display Driver Board or the Controller Power Unit are not functioning correctly and you have another properly functioning 120 Series Monitor, substitute the entire display assembly and check for proper operation. Refer to "Removing the Display Assembly" and "Replacing the Display Assembly". Contact your GE Service Representative for information about upgrading to the larger display assembly.

Removing the Display Assembly

1. Turn off the 120 Series Monitor and disconnect the power cord from the monitor.
2. Remove the nine screws which secure the monitor top cover. Four screws are located on the bottom of the monitor and five screws are located in the back.
3. Remove the cover by sliding it toward the rear of the monitor.
4. Disconnect the display interconnect cable from the DSP Board at J5.
5. Disconnect the ribbon cable from the Recorder Board at J2. Leave the other end connected to the Main Motherboard.
6. Disconnect the Power Supply cable harness from the Recorder Board at J1.
7. Disconnect the ribbon cable from the membrane switch panel. Leave the other end connected to the DSP Board.
8. Remove the four screws which fasten the front bezel to the monitor—two on each side.
9. Gently tilt the bezel forward until it lays flat. Be careful not to disconnect the front end harness cable ferrite beads from their clips. The number of beads varies depending on which options are installed in your monitor.
10. Remove the four screws which attach the display shield to the front bezel. Retain the screws.
11. Set aside, but retain, the display shield.
12. Disconnect the display interconnect cable from J1 on the display Controller Power Unit. Retain this cable.
13. Remove the four standoffs at the corner of the display. Retain the standoffs. Leave the washers and spacers in place on the studs.
14. Upon inspection, you may need to replace the spacer display frame applied to the face of the display. Refer to "Chapter 14, Replacement Parts" for parts information. Contact GE Service Representative for part ordering information.

Replacing the Display Assembly

1. Turn off the 120 Series Monitor and disconnect the power cord from the monitor.
2. Ensure that a washer and spacer is in place on each of the four studs used to mount the display assembly.
3. If the display lens has become dusty, remove it from the front bezel and clean the lens' rear surface with isopropyl alcohol.
4. Re-position the display lens in the front bezel with the gasket lying flat against the bezel. Ensure the shoulder fits into the bezel opening.
5. Apply the spacer frame to the face of the display assembly. Install the display assembly on the four studs.
6. Apply Loctite #242 to the top of each stud, then secure the display assembly with four standoffs.
7. Re-attach the display cable to J1 on the display Controller Power Unit.
8. Replace the display shield and secure with four screws.
9. Ensure the front end harness cable ferrite beads are inserted in the corresponding clips.
10. Replace the front bezel and secure with all four screws.
11. Re-connect the ribbon cable from the DSP Board to the membrane switch panel.
12. Re-connect the Power Supply harness cable to J1 on the Recorder Board.
13. Re-connect the ribbon cable from the Main Motherboard to J2 on the Recorder Board.
14. Re-connect the display interconnect cable to the DSP Board at J5.
15. Replace the monitor top cover and secure with all nine screws.

Upgrading to a 3.5” x 4.5” Display

If you wish to replace an existing 3” x 3.75” display with a larger 3.5” x 4.5” display, refer to “Chapter 14, Replacement Parts”to select the correct kit. The display kit contains a new front bezel assembly and DSP Board.

Equipment Required

You will need the following equipment:

- Phillips Torque Driver
- Flathead Screwdriver
- Anti-Static Wristband
- Static-Free Work Surface

Disassembly

Refer to Figure 7-1 through Figure 7-3 while performing the display upgrade.

NOTE: Unless otherwise instructed, retain all hardware for re-assembly.

1. Turn off the 120 Series Monitor and disconnect the power cord from the monitor.
2. Disconnect all front panel transducers and accessories.
3. Remove the nine screws which secure the monitor top cover. Four screws are located on the bottom of the monitor and five screws are located in the back.
4. Remove the cover by sliding it toward the rear of the monitor.
5. Disconnect the display interconnect cable from the DSP Board at J5.
6. Disconnect switch panel ribbon cable from the DSP Board at J4.
7. Disconnect the recorder output ribbon cable from the Recorder Board at J2. Leave the other end connected to the Main Motherboard.
8. Disconnect the recorder power supply cable harness from the Recorder Board at J1.
9. Disconnect the main switch power harness from the connector at the top of the divider to the recorder cavity.
10. Remove the hold-down cover for the front end boards. Three screws secure the top; one screw is located on the side panel.
11. Disconnect the front panel US1 harness cable from the Ultrasound Board at J5. Guide the plastic cable bushing out of the front-end enclosure.
12. Disconnect the front panel US2 harness cable from the Ultrasound Board at J6 and remove the cable bushing from the enclosure.
13. Disconnect the front panel UA harness cable from the Front End Motherboard at J7.
14. Disconnect the front panel FECG harness cable from the Front end Motherboard at J6. Pull the cable’s ferrite bead out from the retaining clip.
15. *If BP is installed* in the monitor, disconnect the blood pressure tubing from the front panel connector board. Label the tubes “top” and “bottom” using masking tape for future reference.

16. *If $MSpO_2$ is installed* in the monitor, disconnect the front panel $MSpO_2$ harness cable from the Oximeter Carrier Board at J6 and remove the cable bushing from the enclosure. Pull the cable's ferrite bead out from the retaining clip.
17. *If MECG is installed* in the monitor, disconnect the front panel MECG harness cable from the MECG Board at J7 and remove the cable bushing from the enclosure. Pull the cable's ferrite bead out from the retaining clip.
18. Squeeze the top and bottom tabs on the main power switch and push the switch and attached harness through the front bezel.
19. Remove the four screws which fasten the front bezel to the monitor—two on each side.
20. Gently tilt the front bezel forward and lay the whole assembly face down on the table.
21. Remove the two screws which fasten the bottom of the strip chart recorder to the front bezel.
22. Remove the four front recorder mounting screws which secure the frame at the front bezel.
23. Slide the recorder slightly away from the front bezel and then lift the recorder out.
24. *If BP is installed* in the monitor, disconnect the blood pressure tubes from the nipples located at the divider to the recorder cavity. Use masking tape to label the tubes "top" and "bottom". Free the blood pressure tubes from the notch at the top of the DSP Board and drape them over the rear panel of the monitor.
25. Remove the two screws securing the DSP Board to the chassis.
26. Remove the DSP Board from the Main Board.

Reassembly

1. Remove the new DSP Board from its anti-static packaging.
2. Mount the new DSP Board onto the Main Board headers then secure the board to the chassis using the two screws.
3. *If BP is installed* in the monitor, route the blood pressure tubes through the notch at the top of the DSP Board. Attach the tubes to the nipples in the chassis divider paying attention to the top/bottom labels.
4. Remove new front bezel assembly from its packaging.
5. Carefully position the recorder into the front bezel housing.
6. Install the four front recorder mounting screws which secure the frame to the bezel.
7. Install the two screws which secure the strip chart recorder to the bottom of the front bezel.
8. Push the main power harness assembly through the front bezel power switch cutout, from the front to the back, until the switch snaps in place.
9. Carefully reposition the new front bezel. Secure all four screws—two on each side.

10. Connect the front panel US2 harness cable to the Ultrasound Board at J6. Guide the plastic cable bushing into the front-end enclosure until it snaps into place.
11. Connect the front panel US1 harness cable to the Ultrasound Board at J5. Snap the bushing in place in the enclosure.
12. Connect the front panel UA harness cable to the Front End Motherboard at J7.
13. Connect the front panel FECG harness cable to the Front End Motherboard at J6. Mount the cable's ferrite bead in the retaining clip.
14. *If BP is installed* in the monitor, re-connect the blood pressure tubing to the front panel connector board. Pay attention to the top/bottom labeling.
15. *If $MSpO_2$ is installed* in the monitor, connect the front panel $MSpO_2$ harness cable to the Oximeter Carrier Board at J6. Snap the bushing in place in the enclosure. Mount the cable's ferrite bead in the retaining clip.
16. *If MECG is installed* in the monitor, connect the front panel MECG harness cable to the MECG Board at J7. Snap the bushing in place in the enclosure. Mount the cable's ferrite bead in the retaining clip.
17. If $FSp0_2$ *is installed* in the monitor, connect the front panel $FSp0_2$ harness cable to the $FSp0_2$ board at J1. Snap the bushing in place in the enclosure. Mount the cable's ferrite bead in the retaining clip *on the enclosure*. Ensure that the second ferrite bead is mounted on the back of the display shield.
18. Replace the hold-down cover for the front end boards and secure with all four screws.
19. Re-connect the main switch power harness at the recorder divider.
20. Re-connect the recorder power supply cable harness to the Recorder Board at J1.
21. Re-connect the recorder ribbon cable to the Recorder Board at J2.
22. Remove the new switch panel cable from its packaging. Connect one end to the switch panel; connect the other end to the DSP Board at J4.
23. Connect the display interconnect cable to the DSP Board at J5.
24. *If BP is installed* in the monitor, ensure that the blood pressure tubing remains routed through the notch at the top of the DSP Board.
25. Replace the monitor top cover and secure with all nine screws.
26. Replace the monitor power cord.
27. Re-configure the monitor using the Flasher Disk for a 3.5" x 4.5" Display. The Flasher disk re-configures the monitor software to work with the new larger display. Follow the instructions included in the Flasher Display Configuration Kit.

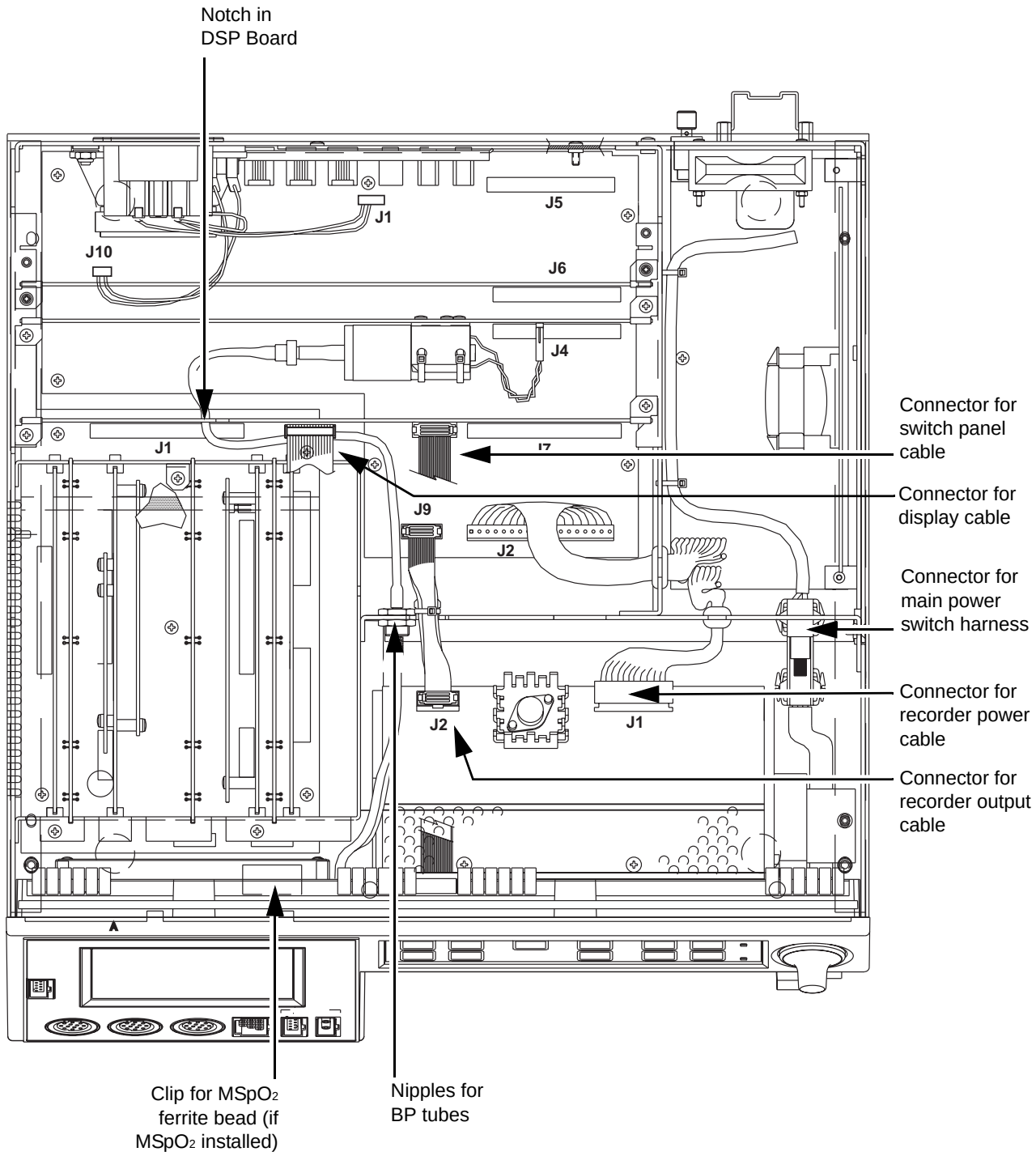


Figure 7-1. Monitor Top View

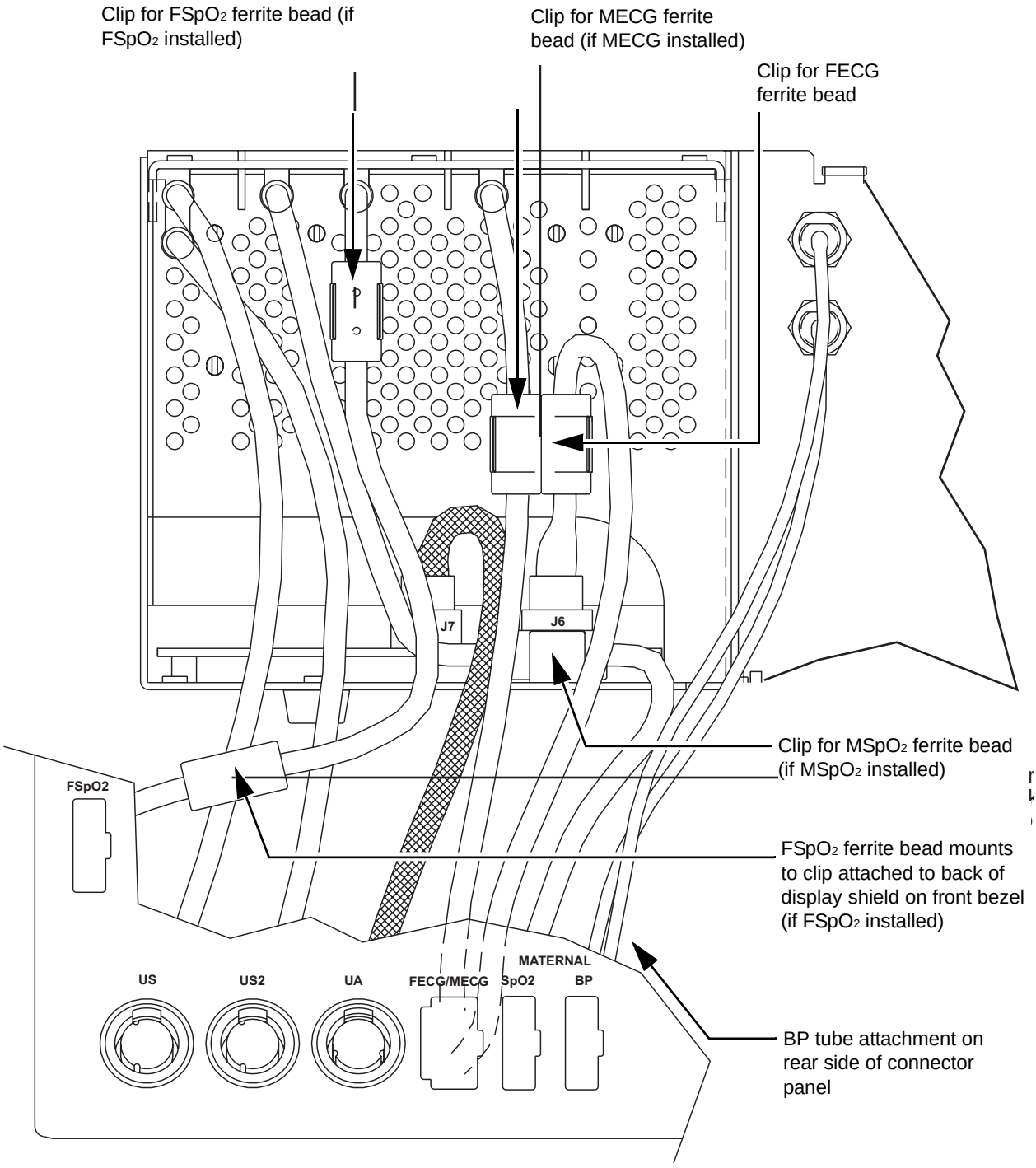

Clip for FSpO2 ferrite bead (if FSpO2 installed)
Clip for MECG ferrite bead (if MECG installed)
Clip for FECG ferrite bead
J7
J6
Clip for MSpO2 ferrite bead (if MSpO2 installed)
FSpO2
FSpO2 ferrite bead mounts to clip attached to back of display shield on front bezel (if FSpO2 installed)
MATERNAL
US
US2
UA
FECG/MECG
SpO2
BP
BP tube attachment on rear side of connector panel

Figure 7-2. Partial Inside Front Panel, Shown with Front Bezel Removed

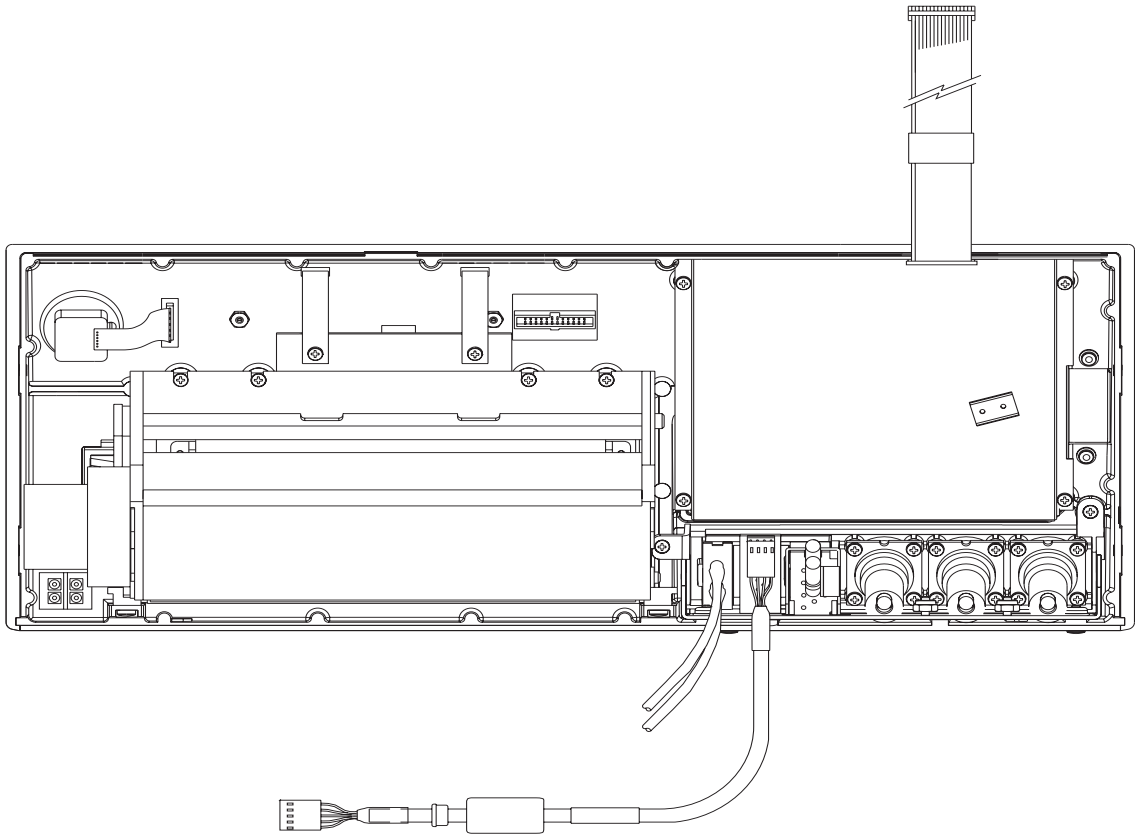


Figure 7-3. Front Bezel

Testing

CAUTIONS

Following completion of the procedure:

LEAKAGE TEST—Perform a leakage and dielectric test on the 120 Series Monitor per applicable standards.

FUNCTIONAL TEST—Perform a functional test of the overall monitor following the instructions provided in “Chapter 6, Functional Checkout Procedure”.

Checking a 3.5” x 4.5” Display

Newer monitors contain a 3.5” x 4.5” display. In troubleshooting, the following methods can be employed to determine whether a problem exists with the display assembly, the 120 Series Monitor DSP Board or the interconnect cable.

Verifying the DSP Board Operation

1. Turn off the 120 Series Monitor.
2. Remove the nine screws which secure the monitor top cover. Four screws are located on the bottom of the monitor and five screws are located in the back.
3. Remove the cover by sliding it toward the rear of the monitor.
4. Unplug the display interconnect cable from J5 on the DSP Board.
5. Turn on the 120 Series Monitor.
6. Using a digital voltmeter, attach the negative lead to J5 (pin 20), ground, on the DSP Board. Attach the positive lead to J5 (pin 1). Verify a reading of +12 Vdc ± 1.2 Vdc. This checks for the presence of the Vcc2 signal.
7. Attach the positive lead to J5 (pin 5) on the DSP Board. Leave the negative lead attached to ground. Verify a reading of +5 Vdc ± 0.25 Vdc. This checks for the presence of the Vcc1 signal.
8. Using an oscilloscope, attach the negative lead to J5 (pin 20), ground, on the DSP Board. Attach the positive lead to J5 (pin 9). Verify the output of a periodic waveform. This checks for the presence of the HSYNCB signal.
9. Attach the positive lead to J5 (pin 7) on the DSP Board. Leave the negative lead attached to ground. Verify the output of a periodic waveform. This checks for the presence of the VSYNCB signal.
10. Attach the positive lead to J5 (pin 11). Leave the negative lead attached to ground. Verify the output of a period waveform. This checks for the presence of the VCKB signal.
11. If you suspect that the DSP Board is not supplying the correct voltage or one of the video signals is missing and you have another properly functioning 120 Series Monitor, substitute the DSP Board and check for proper operation. Contact your GE Service Representative for information about repair/exchange of the DSP Board.
12. If you suspect that the interconnect cable is not working properly, refer to “Chapter 14, Replacement Parts”or contact your GE Service Representative for part ordering information.

13. If you suspect that either the Display Driver Board or the Controller Power Unit are not functioning correctly and you have another properly functioning 120 Series Monitor, substitute the entire display assembly and check for proper operation. Refer to "Removing the Display Assembly" and "Replacing the Display Assembly". Contact your GE Service Representative for ordering information.

Removing the Display Assembly

1. Turn off the 120 Series Monitor and disconnect the power cord from the monitor.
2. Remove the nine screws which secure the monitor top cover. Four screws are located on the bottom of the monitor and five screws are located in the back.
3. Remove the cover by sliding it toward the rear of the monitor.
4. Disconnect the display interconnect cable from the DSP Board at J5.
5. Disconnect the ribbon cable from the Recorder Board at J2. Leave the other end connected to the Main Motherboard.
6. Disconnect the Power Supply cable harness from the Recorder Board at J1.
7. Disconnect the ribbon cable from the membrane switch panel. Leave the other end connected to the DSP Board.
8. Remove the four screws which fasten the front bezel to the monitor—two on each side.
9. Gently tilt the bezel forward until it lays flat. Be careful not to disconnect the front end harness cable ferrite beads from their clips. The number of beads varies depending on which options are installed in your monitor.
10. Remove the four screws which attach the display shield to the front bezel. Retain the screws.
11. Set aside, but retain, the display shield.
12. Disconnect the display interconnect cable from J1 on the display Controller Power Unit. Retain this cable.
13. Remove the four standoffs at the corner of the display. Retain the standoffs. Leave the washers and spacers in place on the studs.

Replacing the Display Assembly

1. Turn off the 120 Series Monitor and disconnect the power cord from the monitor.
2. Ensure that a washer and spacer is in place on each of the four studs used to mount the display assembly.
3. If the display lens has become dusty, remove it from the front bezel and clean the lens' rear surface with isopropyl alcohol.
4. Apply the 5-1/2 inch foam shield to the bottom of the display assembly. Apply a 3-1/2 inch foam shield to each side of the display assembly.
5. Apply the EMI foam gasket on top of the display assembly transformer. (Use the old display assembly as your placement guide.)
6. Re-position the display assembly in the front bezel with the gasket lying flat against the bezel. Ensure the shoulder fits into the bezel opening.
7. Apply Loctite #242 to the top of each stud, then secure the display assembly with four standoffs.
8. Re-attach the display cable to J1 on the display Controller Power Unit.
9. Replace the display shield and secure with four screws.
10. Ensure the front end harness cable ferrite beads are inserted in the corresponding clips.
11. Replace the front bezel and secure with all four screws.
12. Re-connect the ribbon cable from the DSP Board to the membrane switch panel.
13. Re-connect the Power Supply harness cable to J1 on the Recorder Board.
14. Re-connect the ribbon cable from the Main Motherboard to J2 on the Recorder Board.
15. Re-connect the display interconnect cable to the DSP Board at J5.
16. Replace the monitor top cover and secure with all nine screws.

Trimline Tocotransducer Calibration

The Corometrics Trimline tocotransducer must be calibrated using the following procedure for use with the 120 Series Monitor.

Equipment Required

Refer to "Chapter 14, Trimline Tocotransducer Calibration" for part numbers.

- Digital voltmeter: DM501 or equivalent with x1 probe or leads
- Corometrics Common Mode Rejection (CMR) Test Jack (Refer to Figure 7-4.)
- Calibrated 120 Series Monitor
- Anti-static Wristband
- Static-Free Work Surface
- Screwdriver or potentiometer adjustment tool
- 52.5 gram weight
- Sealing tape
- Torque seal

Procedure

During this procedure, refer to Figure 7-5 for the location of potentiometers in the Trimline tocotransducer.

NOTE: When performing this procedure, keep in mind that due to the nature of the circuitry in the Trimline Tocotransducer, there is a stabilization time of approximately two seconds for any output voltage. After adjusting a potentiometer, verify that the output has stabilized prior to taking a voltage reading.

1. Remove the nameplate and sealing tape from the top cover of the Trimline Tocotransducer.
2. Set the GAIN and ZERO CTR potentiometers in the tocotransducer fully counterclockwise.
3. Set the ZERO TRIM potentiometer to its mid-position—approximately six turns from fully counterclockwise.
4. Locate TP6 and TP2 or TP3 (ground) on the FECG/UA Board in the 120 Series Monitor.
5. Connect the positive lead of the digital voltmeter to TP6; connect the negative lead to TP2 or TP3.
6. Apply power to the 120 Series Monitor; then plug the CMR Test Jack into the monitor's front panel UA connector.
7. Measure the voltage at TP6 and record the value.
8. Replace the CMR Test Jack with the tocotransducer to be calibrated.
9. Place the tocotransducer on a flat surface so that the button is face up, then center the 52.5 gram weight on the button.

10. Adjust the ZERO CTR and/or the ZERO TRIM potentiometer(s) so that the voltage measured across TP6 and TP2 (or TP3) matches the reading recorded in step 7, ± 0.04 V. This voltage is referred to as the WEIGHT ON voltage.

    - The ZERO CTR potentiometer provides course adjustment.
    - The ZERO TRIM potentiometer provides fine adjustment.

11. Remove the weight and observe the voltage reading; this voltage is referred to as the WEIGHT OFF voltage. A correctly adjusted transducer will show a voltage change of +0.637 V ± 0.04 V from the WEIGHT ON to WEIGHT OFF voltage. If the change is less than 0.597 V, adjust the GAIN potentiometer counterclockwise to increase the gain. If the change is more than 0.677 V, then adjust the GAIN potentiometer clockwise to decrease the gain.

12. Repeat step 9 through step 11 until the change in voltage between the WEIGHT ON and WEIGHT OFF conditions falls into specification.

13. Torque seal all potentiometers. Re-seal with waterproof sealing tape and re-install the nameplate.

CAUTION

REPEAT MEASUREMENTS—Due to offset voltages induced by the circuitry in the Trimline Tocotransducer, it is necessary to adjust the change in voltage between the WEIGHT ON condition and WEIGHT OFF condition—instead of simply adjusting the output voltage for each condition. Adjusting the GAIN potentiometer while monitoring the voltage at TP6 may show little or no voltage change as the potentiometer is being adjusted. However, when the weight is again placed on the button, the output voltage for this condition may have changed significantly. In summary, it is necessary to adjust the GAIN potentiometer and then recheck the voltages during both the WEIGHT ON condition and the WEIGHT OFF condition to determine the effectiveness of the adjustment. As stated in step 12, the procedure is repeated until the voltages fall into specification for both conditions.

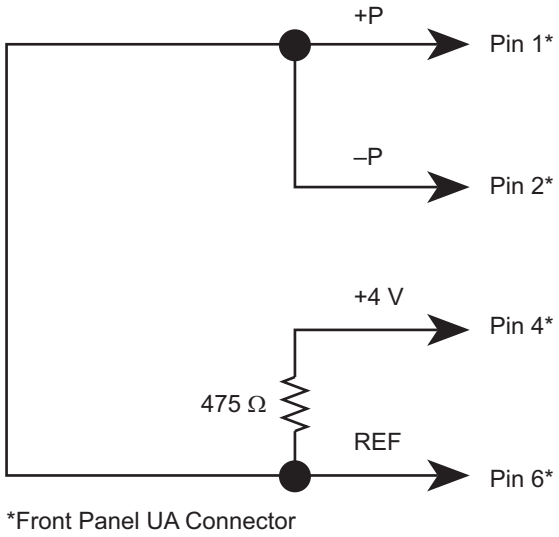


Figure 7-4. CMR Test Jack

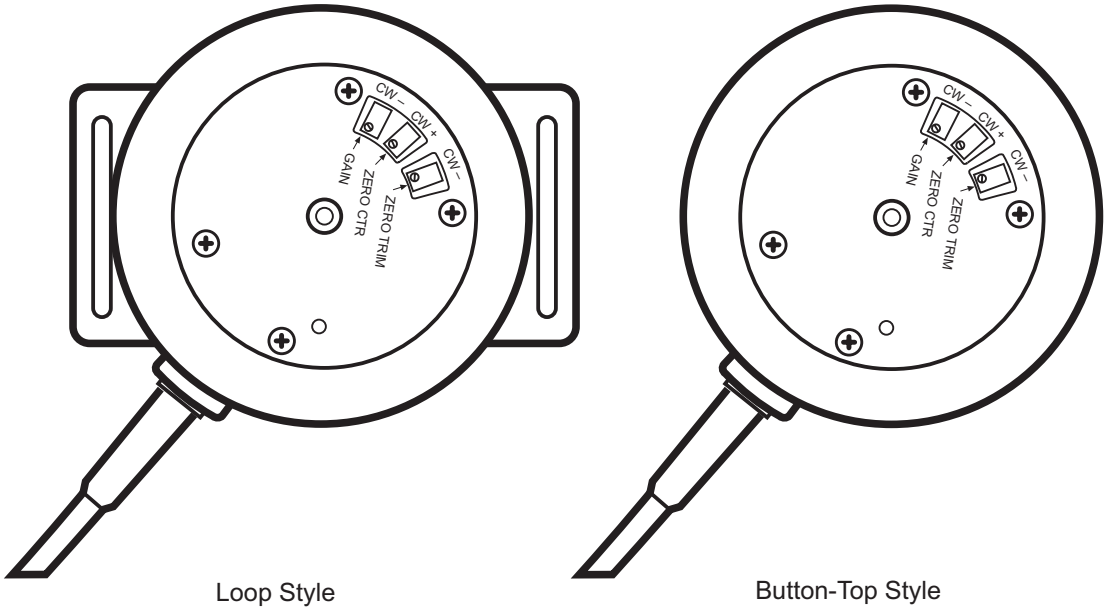


Figure 7-5. Trimline Tocotransducer Potentiometer Locations

Nautilus Tocotransducer Calibration

Calibrating a Nautilus Tocotransducer requires a Calibration Kit. Refer to “Chapter 14, Nautilus Tocotransducer” to order the correct kit.

Equipment Required

You will need the following:

- Phillips Head Torque Driver
- Screw Cap Extraction Tool
- Digital Voltmeter: DM501 or equivalent with x1 probe or leads
- Common Mode Rejection (CMR) Test Jack (Figure 7-4)
- Potentiometer Adjustment Tool
- 52.5 gram weight

  NOTE: You will need a specific weight to calibrate the Nautilus Tocotransducer. Refer to "Chapter 14, Nautilus Tocotransducer" for part number information.

- Torque Seal
- Loctite Adhesive #454 (recommended)
- Anti-Static Wristband
- Static-Free Work Surface
- Calibrated 120 Series Monitor

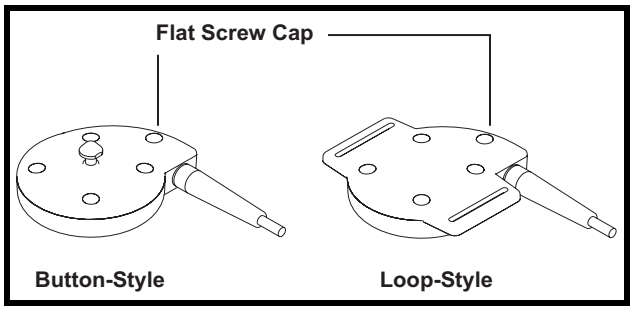


Figure 7-6. Sealing Screw Caps

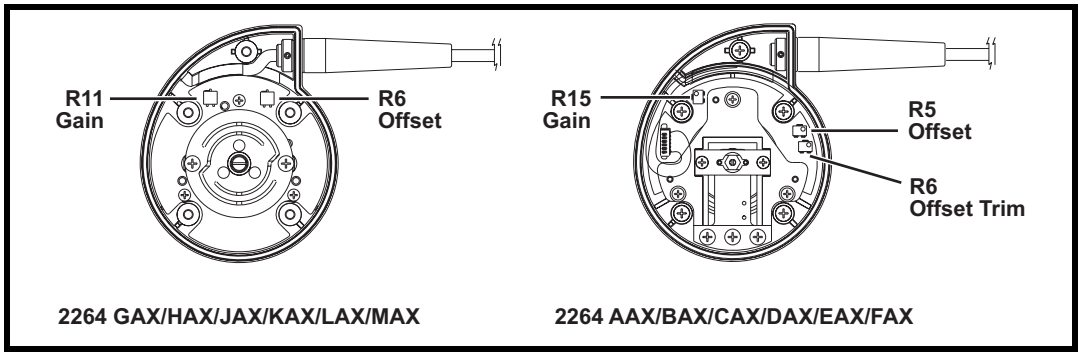


Figure 7-7. Nautilus Tocotransducers—Cover Removed

Calibration Procedure

Disassembly

CAUTION
HANDLING—Take care not to damage the transducer base sealing groove.

1. Turn off the monitor.
2. Unplug the transducer from the monitor.
3. Use the screw cap extraction tool to pry off the five screw caps (Figure 7-6). Discard all caps.
4. Remove the five sealing screws and discard.
5. Remove the transducer cover and flat-seal o-ring. Discard both items.

Calibration for Cat. No. (REF) 2264 GAX/HAX/JAX/KAX/LAX/MAX

1. Set the Gain (R11) and Offset (R6) potentiometers fully clockwise.
2. Connect the positive lead of the digital voltmeter to TP6 on the FECG/UA board; connect the negative lead to TP2 or TP3.
3. Turn on the monitor.
4. Plug the CMR Test Jack into the monitor's UA connector.
5. Measure the voltage across the test points and record the value.
6. Replace the CMR Test Jack with the transducer to be calibrated.
7. Place the tocotransducer on a flat surface so that the button is face up, then center the 52.5 gram weight on the pressure sensitive button.
8. Adjust the Offset (R6) potentiometer so that the voltage matches the reading recorded in 5 ± 0.04 V. This voltage is referred to as the "weight on" voltage.
9. Remove the weight and observe the voltage reading; this voltage is referred to as the "weight off" voltage. A correctly adjusted transducer will show a voltage change of +0.637 V ± 0.04 V. If the change is less, adjust the Gain (R11) potentiometer counterclockwise to increase the gain. If the change is more, adjust the Gain (R11) potentiometer clockwise to decrease the gain.
10. Repeat 7 through 9 until the change in voltage between the "weight on" and "weight off" conditions falls into specification.
11. Torque seal all potentiometers.

Calibration for Cat. No. (REF) 2264 AAX/BAX/CAX/DAX/EAX/FAX

1. Set the Gain (R15) and Offset (R5) potentiometers fully counterclockwise.
2. Set the Offset Trim (R6) potentiometer to its mid-position—approximately six turns from fully counterclockwise.
3. Connect the positive lead of the digital voltmeter to TP6 on the FECG/UA board; connect the negative lead to TP2 or TP3.
4. Turn on the monitor.
5. Plug the CMR Test Jack into the monitor's UA connector.
6. Measure the voltage across the test points and record the value.
7. Replace the CMR Test Jack with the transducer to be calibrated.
8. Place the tocotransducer on a flat surface so that the button is face up, then center the 52.5 gram weight on the pressure sensitive button.
9. Adjust the Offset (R5) and Offset Trim (R6) potentiometers so that the voltage matches the reading recorded in 6 ± 0.04 V. This voltage is referred to as the "weight on" voltage.
   - The Offset (R5) potentiometer provides course adjustment.
   - The Offset Trim (R6) potentiometer provides fine adjustment.
10. Remove the weight and observe the voltage reading; this voltage is referred to as the "weight off" voltage. A correctly adjusted transducer will show a voltage change of +0.637 V ± 0.04 V. If the change is less, adjust the Gain (R15) potentiometer counterclockwise to increase the gain. If the change is more, adjust the Gain (R15) potentiometer clockwise to decrease the gain.
11. Repeat step 8 through step 10 until the change in voltage between the "weight on" and "weight off" conditions falls into specification.
12. Torque seal all potentiometers.

Reassembly

CAUTIONS

VISIBLE INSPECTION—Ensure the base sealing groove, flat-seal o-ring, sealing surface, and sealing screws are free of visible surface defects, dust, dirt, and foreign material.

SINGLE-USE COMPONENTS—Do ***not*** reuse case top, flat-seal o-ring, sealing screws, or screw caps. Discard these items *each* time a transducer is opened.

SEALS—Wetting of seals is ***not*** required.

1. Install new flat-seal o-ring.
2. Install case top and tighten five sealing screws. Hand tighten each screw a small amount going in a clockwise direction, skipping every other screw. Repeat until all screws are torqued to 48 in-oz.
3. Apply one drop of Loctite adhesive* in the hole for the flat screw cap (Figure 7-6). Insert flat screw cap and press into place.
4. Apply one drop of Loctite adhesive* in the hole for a curved screw cap. Insert the curved screw cap being careful to align it according to the curvature of the case top prior to pressing into place. Repeat for the remaining three curved screw caps.
5. For button-style transducers only: install and torque belt knob to 48 in-oz.

Testing the Tocotransducer

CAUTIONS

Following completion of the calibration procedure:

LEAKAGE TEST—Perform a leakage and dielectric test on the tocotransducer per applicable standards.

FUNCTIONAL TEST—Perform a functional response test on the tocotransducer. Refer to “Tocotransducer Test” on page 6-25.

* *Using Loctite Adhesive #454 is recommended in order to secure the screw caps.*

Maternal SpO_2 Calibration

The 120 Series Monitor automatically calibrates the pulse oximetry module upon power up, whenever a new sensor is attached, and at periodic intervals during use. The intensity of the sensor's LEDs are also automatically adjusted to compensate for differences in tissue density.

Chapter 8

Self-Tests

This section of the manual provides information which will help the biomedical engineer isolate 120 Series Monitor problems to the board or component level. The 120 Series Monitor incorporates a number of software-based self-test diagnostic features designed to enhance verification of the unit's internal circuitry. This section of the manual is not intended as a substitute for proper professional training, or familiarity with the 120 Series Monitor. Only qualified service personnel should attempt servicing the 120 Series Monitor.

This chapter contains the following information:

Power-On Diagnostic Tests 8-2
Monitor Self-Test 8-3
Error Log Screen 8-5
Diagnostic Control Screen 8-11
Corolan Address Check 8-17
J102 Analog Output Connector DAC Static Test 8-18
RS-232C Connector Loopback Test 8-21

Power-On Diagnostic Tests

Upon power-up, the 120 Series Monitor's Main Motherboard and DSP Board perform a number of tests before allowing the monitor to enter the normal operational mode. After setting the **Power** switch to the on (**I**) position, the tests run for approximately two seconds. If all tests pass, the monitor enters the normal operational mode. If a test fails, you will see one of the following error messages centered in the display:

SYSTEM FAULT: ROM

SYSTEM FAULT: RAM

SYSTEM FAULT: DSP

The first two errors indicate a problem on the Main Motherboard. The last error indicates an error on the DSP Board. If the monitor displays any of these messages, turn off the monitor and contact your Corometrics Service Representative.

Monitor Self-Test

The 120 Series Monitor contains test routines which verify the unit's calibration and internal circuitry. These routines are initiated by depressing the front panel **Test** pushbutton. The test results are printed on the strip chart recorder paper, verifying the integrity of the unit.

It is recommended practice to initiate the self-test feature at the beginning of each monitoring session.

1. Check the **Voltage Selection** switch on the rear panel of the 120 Series Monitor and ensure it matches the line voltage of the receptacle to be used. Connect the detachable line cord to the rear panel power entry module; plug the other end into a hospital grade, grounded wall outlet of appropriate voltage.
2. Place the front panel **Power** switch in the *on* (**I**) position. When the power is first turned on, verify that three tones are emitted from the rear panel speaker and the green power on indicator is lit.
3. Depress the front panel **Test** pushbutton and verify the following:
   - All display pixels illuminate for one second and then all are extinguished for one second. Afterwards, a vertical line moves across the screen from left to right, followed by a horizontal line moving from top to bottom. The display then remains black.
   - The yellow **Record** indicator illuminates.
   - The message TEST: ARE ALL DOTS PRINTED? is printed followed by two vertical lines which should appear continuous. Discontinuous lines may be an indication of damaged printhead elements if gaps occur in the same place on both lines. Simulated trends of 30 and 240 BPM (or 50 and 210 BPM, depending on the paper installed) are printed on the top grid. Simulated pressure trends at 0 and 100 mmHg are printed on the bottom grid. The values are also printed in the center margin of the strip chart. Refer to Figure 8-1.
   - After the recorder test above, the display returns to the main screen; then the software generates a 120 BPM rate in the FHR1 area and a 180 BPM rate in the FHR2 area, with both mode titles displaying **TEST**.
   - The monitor adds 50 mmHg to the present pressure level and displays this value in the UA display area; the mode title displays **TEST**.

NOTE: The monitor will add 50 mmHg to raw pressure data. In other words, the value is always referenced to 0 mmHg regardless of any UA referencing attempt.

4. The recorder returns to its original on, off, or maternal-only mode state from when the **Test** pushbutton was depressed.

NOTE: To disable the test, depress the **Test** pushbutton or open the recorder door.

NOTE: If the simulated fetal heart rate trends do not appear in the correct positions on the strip chart recorder paper, ensure the monitor's vertical scale setting matches the type of paper being used, i.e. 30 BPM/cm or 20 BPM/cm.

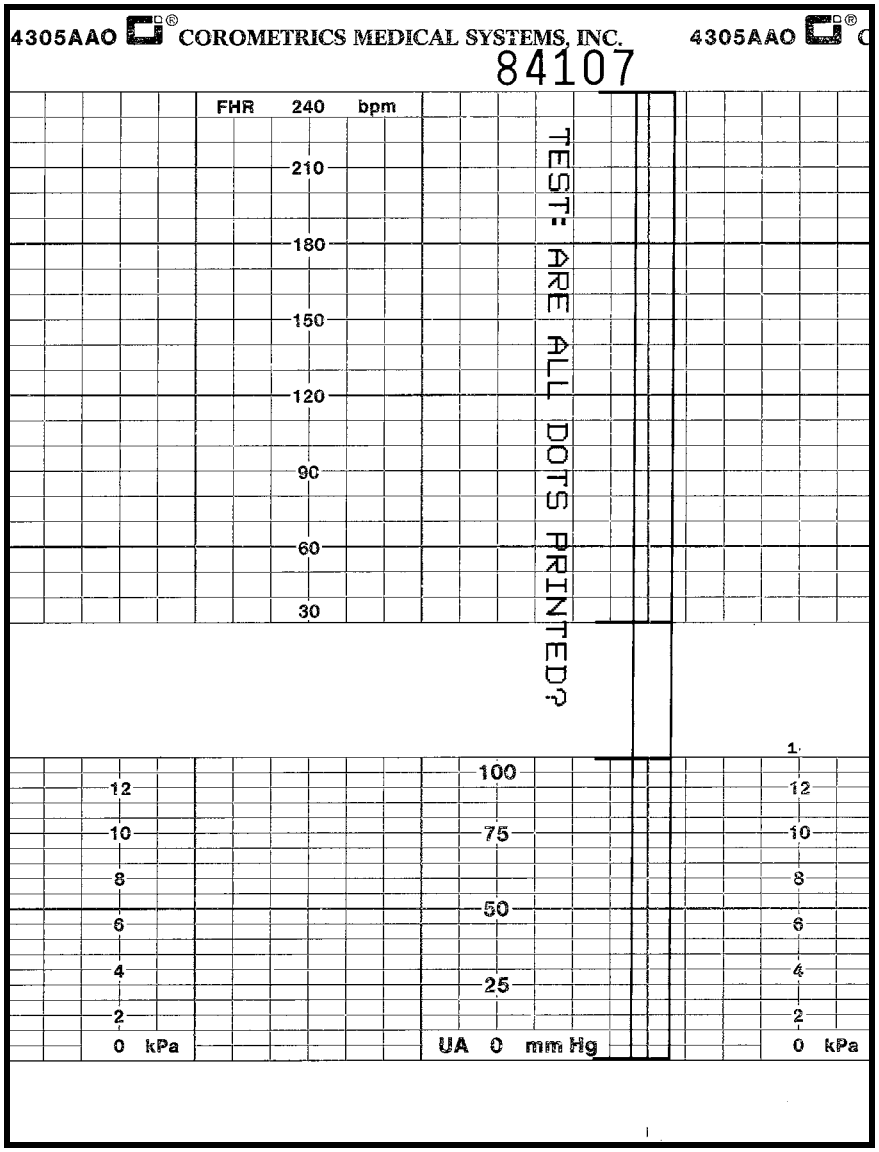


Figure 8-1. 120 Series Self-Test

Error Log Screen

The Error Log screen, Figure 8-2, displays a service log of the 120 Series Monitor. The service log is helpful to service representatives when diagnosing intermittent problems. There are up to 230 error codes which can be detected by the monitor. The Error Log is comprised of multiple pages with up to 20 error codes per screen. Each screen displays three columns:

- The Error ID column lists the error code. The codes are defined in Table 8-1.
- The Count column lists the number times the error code has occurred.
- The Data column lists other information associated with the error code. This column is for factory use only.

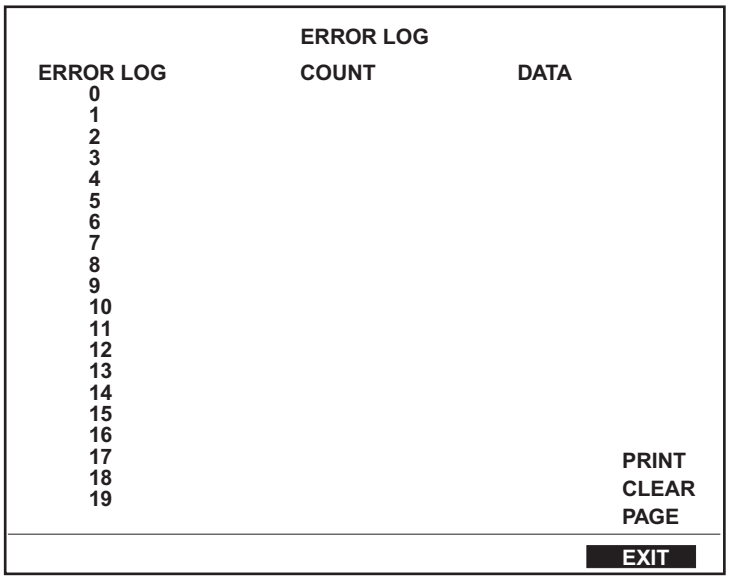


Figure 8-2. Error Log Screen

To use the Error Log screen:

1. Select the **SERVICE** softkey from the General Setup screen.
2. The Service Lock screen appears.
3. Enter the correct access code; the Install Options screen displays.
4. Select the **LOG** softkey from the Install Options screen.
5. The first Error Log screen displays.
6. Use the **PAGE** softkey to display the next screen (page), if applicable. The last page wraps back to the first page.
7. Use the **PRINT** softkey to print the displayed screen (page) on the strip chart recorder.
8. Use the **CLEAR** softkey to clear all the error log from the battery-backed RAM.

Table 8-1. Error Codes

Error #	Description
0–50	Mailbox overflows; correspond to mailbox IDs
51–54	Reserved for future use
55	Corolan address test failed
56–61	Reserved for future use
62	SCC1 HDLC length error—Corolan
63	SCC2 framing error—J109
64	SCC3 framing error—J110
65	SCC1 HDLC non-octet alignment error—Corolan
66	SCC2 parity error—J109
67	SCC3 parity error—J110
68	SCC1 overflow error—Corolan
69	SCC2 overflow error—J109
70	SCC3 overflow error—J110
71	SCC1 HDLC CRC error—Corolan
72	SCC2 break error—J109
73	SCC3 break error—J110
74	SCC1 HDLC abort sequence error—Corolan
75	SCC1 carrier detect lost error—Corolan
76–79	Reserved for future use

Table 8-1. Error Codes (Continued)	
Error #	Description
80	6894 Channel A communications error—J111
81	6894 Channel B communications error— $FSpO_2$
82	6894 Channel C communications error—$MSpO_2$
83	6894 Channel D communications error—NBP
84–89	Reserved for future use
90	DSP communications watchdog timer
91	DSP Error 1—CRC on program in flash ROM is bad
92	DSP Error 2—A/D converter conversion time test failed
93	Unused
94	DSP Error 4—Run time RAM test failed
95	DSP Error 5—Power up test program sequence failed
96	DSP Error 6—Power up program RAM test failed
97	DSP Error 7—Power up data RAM test failed
98	DSP Error 8—Run time CPU utilization exceeded 100%
99	DSP Error 9—Supply voltages, voltage reference, or A/D invalid
100	DSP Error 10—DSP–MAIN data queue nearly full
101	DSP Error—DSP–MAIN data queue full; data is being lost
102	DSP Error—Power supply warning
103	DSP warm start
104	DSP—reserved for future use
105	DSP—reserved for future use
106	DSP—reserved for future use
107	DSP—reserved for future use
108	DSP—reserved for future use
109	DSP—reserved for future use
110	CPU requests for DSP packet re-transmission
111	Erroneous packets received from DSP
112–119	Reserved for future use
120	CAS Error 0—No error
121	CAS Error 1—Unused
122	CAS Error 2—Self-test failed

Table 8-1. Error Codes (Continued)	
Error #	Description
123	CAS Error 3—No error
124	CAS Error 4—reserved for future use
125	CAS Error 5—reserved for future use
126	CAS Error 6— Loose cuff
127	CAS Error 7—Air leak
128	CAS Error 8—Air pressure error
129	CAS Error 9—Cuff positioning error
130	CAS Error 10—Range exceeded
131	CAS Error 11—Excessive motion
132	CAS Error 12—Overpressure
133	CAS Error 13—Signal saturated
134	CAS Error 14—Pneumatic leak
135	CAS Error 15 —System failed
136	CAS receive error
137	CAS reset error
138	CAS message type error
139	CAS timeout error
140	NPB $MSpO_2$—Internal error
141	NPB $MSpO_2$—RAM error
142	NPB $MSpO_2$—ROM error
143	NPB $MSpO_2$—Checksum error
144	NPB $MSpO_2$— Write error
145	NPB $MSpO_2$—Range error
146	NPB $MSpO_2$—Calibration failed
147	NPB $MSpO_2$—Calibration on error
148	NPB $MSpO_2$—Calibration denied error
149	NPB $MSpO_2$—Syntax error
150	NPB $MSpO_2$—Fast message error
151	NPB $MSpO_2$—Slow message error
152	NPB $MSpO_2$—Communications error
153	NPB $MSpO_2$—Reply error

Table 8-1. Error Codes (Continued)	
Error #	Description
154	NPB MSpO2—Watchdog timer error
155–159	Reserved for future use
160	Model 2116B Keyboard parity error
161–169	Reserved for future use
170	NPB FSpO2—Fast message error
171	NPB FSpO2—Slow message error
172	NPB FSpO2—Communications error
173	NPB FSpO2—Reply error
174	NPB FSpO2—Watchdog timer error
180	NPB FSpO2—Internal errors
181–199	Reserved for future use
200	CPU—Watchdog timer error
201	CPU—RAM error
202	CPU—ROM error
203	CPU—CRC fault
204	CPU—Processor exception fault
205	CPU—Bus error
206	CPU—Address error
207	CPU—Instruction error
208	CPU—Battery RAM error
209	CPU —Event fault
210	Task 0 timeout
211	Task 1 timeout
212	Task 2 timeout
213	Task 3 timeout
214	Task 4 timeout
215	Task 5 timeout
216	Task 6 timeout
217	Task 7 timeout
218	Task 8 timeout
219	Task 9 timeout

Table 8-1. Error Codes (Continued)	
Error #	Description
220	Task 10 timeout
221	Task 11 timeout
222	Task 12 timeout
223	Task 13 timeout
224	Task 14 timeout
225	Task 15 timeout
226–229	Reserved for future use
230	Power fault
231–239	Reserved for future use

Diagnostic Control Screen

The Diagnostic Control screen, Figure 8-3, is used to perform the following diagnostic self-tests:

- manometer pressure check;
- pneumatic pressure check;
- recorder calibration test;
- CPU software version number;
- DSP software version number;
- monitor run time;
- recorder run time;
- Main Board SW1 switch setting summary;
- Corolan network status;
- Corolan address check;
- softkey to access J102 test screen; and
- softkey to perform a memory dump.

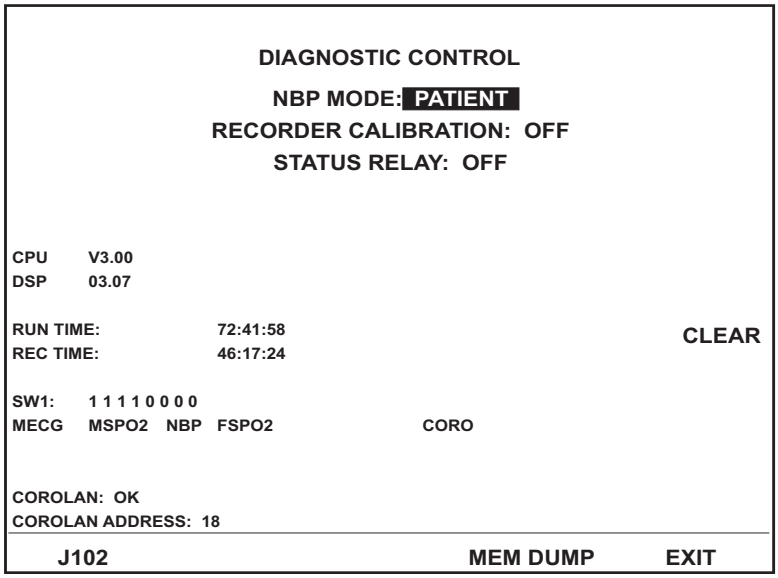


Figure 8-3. Diagnostic Control

To access the Diagnostic Control screen:

1. Select the **SERVICE** softkey from the General Setup screen.
2. The Service Lock screen appears.
3. Enter the correct access code; the Install Options screen displays.
4. Select the **TESTS** softkey from the Install Options screen.
5. The Diagnostic Control screen displays.

Recorder Calibration Test

This test provides a method of testing the recorder calibration alignments.

1. Use the Trim Knob control to set the recorder calibration field on the Diagnostic Control service mode screen to ON. The recorder prints three continuous horizontal lines at: 0 mmHg, 30 bpm, and 240 bpm. The recorder prints a vertical line spanning across both grids every 3/16 inch. Refer to Figure 8-4.
2. Use this test while performing the adjustments in "Chapter 10, Strip Chart Recorder Servicing". The test will continue to print the lines until you cycle power on the monitor or set the calibration field on the Diagnostic Control screen back to OFF.

.

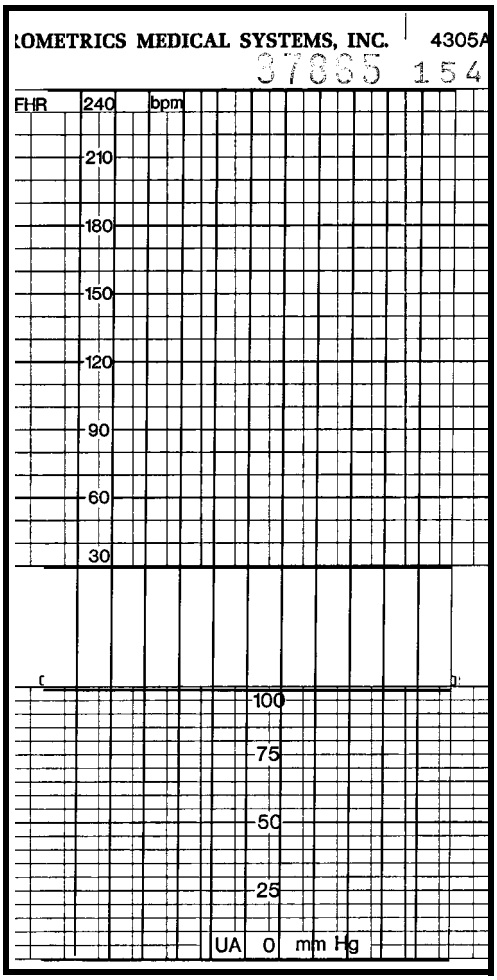


Figure 8-4. Recorder Calibration Test

CPU Version

This field displays the software version number of the main processor installed on the Main Board in your monitor.

DSP Version

This field displays the software version number of the processor installed on the DSP Board in your monitor.

Run Time

This field displays the amount of time the monitor has been turned on—since the field was cleared. The time is displayed in hours, minutes, and seconds. To clear this field (reset the timer), activate the **CLEAR** softkey to the right of the run time field.

NOTE: The **CLEAR** softkey also resets the recorder time field.

Recorder Time

This field displays the amount of time the recorder has been turned on (or in maternal-only mode)—since the field was cleared. The time is displayed in hours, minutes, and seconds. To clear this field (reset the timer), activate the **CLEAR** softkey to the right of the recorder time field.

NOTE: The **CLEAR** softkey also resets the monitor run time field.

Main Board SW1 Switch Settings

This area of the display allows you to see the hardware switch settings (SW1) on the Main Motherboard (No. 11619)—without removing the cover of the monitor. The switch settings are displayed from left (SW1-8) to right (SW1-1). In addition, for some switches, a descriptive annotation is displayed on the line below. Refer to Table 8-2.

Example 1: If you have MECG, $MSpO_2$, NBP, and $FSpO_2$ installed in your monitor; the clock speed set to 20 MHz; the J102 output levels set to Corometrics; and the unit is in the normal operational mode: the screen displays:

1 1 1 1 1 0 0 0
MECG MSPO2 NBP FSPO2 CORO

Table 8-2. Main Board SW1 Switch Settings					
Switch #	Description	On (0) Position		Off (1) Position	
		State	Display Notation	State	Display Notation
8	MECG Option	Disabled		Enabled	MECG
7	$MSpO_2$ Option	Disabled		Enabled	MSPO2
6	NBP Option	Disabled		Enabled	NBP
5	$FSpO_2$ Option	Disabled		Enabled	FSPO2
4	Clock Speed	16 MHz	16 MHz	20 MHz	
3	Unused	—		—	
2	J102 Output Levels	Corometrics	CORO	Hewlett-Packard	
1	Factory Test	Disabled		Enabled	TEST

Corolan Network Status

If Corolan Address Checking is *disabled* on the Install Options screen, this field will normally display NO ADDRESS. If Corolan Address Checking is *enabled* on the Install Options screen, the monitor periodically performs an address test on the Corolan wallplate the monitor is attached to. If the wallplate address lines are intact, this field will display an OK status. If the monitor detects a problem, the monitor automatically goes offline from the Corolan network. Table 8-3 provides an explanation of the more common status indications that can be listed in this field.

Table 8-3. Corolan Network Status Messages	
Message	Meaning
OK	Monitor is successfully communicating with the Corolan master device (e.g. QS Server).
JUST STARTED	Contact GE Service Representative.
ADDRESS NEVER CHECKED	
FLOATING ADDRESS	There is a faulty address line in the wallplate.
INVALID ADDRESS CHANGE	A wallplate has been changed from one address to another. This could be the result of a partially disconnected cable.
ADDRESS KEEPS CHANGING	Contact GE Service Representative.
ADDRESS CHANGING	

Table 8-3. Corolan Network Status Messages	
Message	Meaning
NO ADDRESS	Wallplate cable may be disconnected; or Corolan address checking is disabled.
NO DATA YET	Contact GE Service Representative.
NEVER INTERRUPTED	There is no communication with the Corolan master device (e.g. QS Server). The master device is not polling the monitor.
NO RECENT INTERRUPT	The monitor was successfully communicating with the Corolan master device (e.g. QS Server); however, two minutes have passed since activity.
DRIVER NOT RUN	Contact GE Service Representative.
TRANSMITTING	
LONG TRANSMISSION	
IN TEST MODE	
NO RECENT RECEPTION	
PACKET ERROR	
PACKET TOO SHORT	
SIM RECEIVED	
DISC RECEIVED	
OFFLINE ADDRESS CONTENTION	Two devices (monitors) have the same wallplate address. Both devices have automatically been taken offline.
WAS OFFLINE	Contact GE Service Representative.
HAD DISC ADDRESS	
CRC ERROR	
UNKNOWN PACKET TYPE	
RECENT ADDRESS CONTENTION	A monitor has just been turned on using the same wallplate address as another monitor. If the situation continues, this message will change to OFFLINE ADDRESS CONTENTION. Disconnect both monitors from wallplate. Check wallplate addresses. Re-connect.
SOME ADDRESS CONTENTION	
PACKET NOT A POLL	Contact Corometrics Service Representative.
NO NETWORK ACTIVITY	Twenty seconds have elapsed since last network activity detected.
15 SEC SINCE ACTIVITY	Fifteen seconds have elapsed since last network activity detected.
10 SEC SINCE ACTIVITY	Ten seconds have elapsed since last network activity detected.
5 SEC SINCE ACTIVITY	Five seconds have elapsed since last network activity detected.
AWAITING MANAGER DISCONNECT	Contact Corometrics Service Representative.
NO SNRM YET	

Table 8-3. Corolan Network Status Messages	
Message	Meaning
AWAITING POLL	The Corolan master device (e.g. QS Server) re-started and sent an initial handshaking message; however no further communication occurred.
MANAGER NOT ACTIVE	Contact GE Service Representative.
MANAGER TOO SLOW	
MANAGER RUNNING SLOW	
AWAITING FIRST PACKET DATA	Fifteen seconds have elapsed since monitor was first turned on. (Data is usually sent in 15-second packets.)
NO I FRAME FORMATTED YET	Contact GE Service Representative.
TRANSMIT ON NEXT POLL	The monitor has received data and will respond on the next poll from the master device (e.g. QS Server).
IN RE-TRANSMIT DELAY	Contact GE Service Representative.
TRANSMISSION RETRIED	
DATA OVERFLOW	
POLLS 15 SEC APART	
POLLS 2 SEC APART	
BACKLOG	

Corolan Address Check

The Diagnostic Control service mode screen provides an indication of whether a monitor is connected to a Corolan network and if so, provides the wallplate address.

If the monitor is not connected to a Corolan network, or if there is a wallplate address error and the monitor is automatically taken offline, the message **NO ADDRESS** appears at the bottom left of the screen.

If the monitor is connected to a Corolan network, the wallplate address is identified in the bottom left of the screen.

J102 Analog Output Connector DAC Static Test

This screen displays the J102 pin numbers, the signal descriptions, the range of allowable values for measured voltages, the expected output voltages, and the settings (meaning) adjustable using the Trim Knob control. Use this screen while verifying and calibrating the digital-to-analog converters (DACs) on the Communications Board (No. 13388 or 15297).

1. Access the Diagnostic Control screen. (Refer to page 8-10 in the *120 Series Monitor Service Manual* for instructions.)
2. Use the Trim Knob control to activate the **J102** softkey at the bottom of the screen. The J102 Analog Output Connector screen displays (see Figure 8-5.)
3. The Range and Voltage fields can be displayed using a decimal point or a comma as a separator. Each activation of the **DECIMAL** softkey at the bottom of the screen alternates between using a decimal and a comma.
4. Use the Trim Knob control to cycle through the available settings for each field. The expected voltage for each J102 pin number changes accordingly.

Verification

For each pin, select a value in the Meaning field and measure the expected output.

Analog Ground

This field is not adjustable. Use J102, pin 3 as a ground when making measurements on other pins.

HR1 and HR2

Use the Trim Knob control to select: – – – (0 BPM) or 30–240 BPM in increments of 1 BPM.

UA

Use the Trim Knob control to select 0–100 relative units in increments of 1 relative unit.

HR1 Mode

Use the Trim Knob control to select: – – –, FECG, OFF, US, or INOP.

HR2 Mode

Use the Trim Knob control to select: TEST, FECG, INOP, US, or MECG.

UA Mode

Use the Trim Knob control to select: – – –, INOP, OFF, IUP, or TOCO.

Markout*, Check Paper*, FMD1, and FMD2

Use the Trim Knob control to alternate between ON and OFF.

NOTE: Signal names followed by an asterisk (*) or slash (/) are active low.

Calibration

For calibration, you must use the specific values listed in Table 8-4 (Corometrics output levels) or Table 8-5 (Hewlett-Packard output levels). This tests the high and low ranges for the HR1, HR2, and UA signals. If a measured value does not fall within the given range, adjust the corresponding potentiometer accordingly (on Communications Board, No. 13388 or 15297).

J102

PIN	SIGNAL	RANGE	VOLTAGE	MEANING
3	ANALOG GND	0.00	0.0	
7	HR1	±1.2	–1.20	– – – BPM
22	HR2	±1.2	–1.20	– – – BPM
2	UA	±1.2	–1.20	0
17	HR1MODE	±10	–10.00	
1	HR2MODE	±10	–10.00	TEST
24	UAMODE	±10	–10.00	
20	MARKOUT*	0–5	5	OFF
18	CHK PAPER*	0–5	5	OFF
14	FMD1	0–5	0	OFF
15	FMD2	0–5	0	OFF

DECIMAL EXIT

Figure 8-5. J102 Analog Output Connector Screen

Table 8-4. DAC Output Voltages and Adjustment Points for Corometrics Central Station Outputs				
Analog Signal	Measurement Site	Service Screen Setting	Expected Voltage	Adjustment Site
HR1	J102, pin 7	– – –	–1.2 V ± 10 mV	R18
		240 BPM	+1.2 V ± 10 mV	R20
HR2	J102, pin 22	– – –	–1.2 V ± 10 mV	R27
		240 BPM	+1.2 V ± 10 mV	R29
UA	J102, pin 2	0 relative units	–1.2 V ± 10 mV	R42
		100 relative units	+1.2 V ± 10 mV	R44

Table 8-5. DAC Output Voltages and Adjustment Points for Hewlett-Packard Central Station Outputs				
Analog Signal	Measurement Site	Service Screen Setting	Expected Voltage	Adjustment Site
HR1	J102, pin 7	240 BPM	+2.4V ± 10 mV	R20
HR2	J102, pin 22	240 BPM	+2.4 V ± 10 mV	R29
UA	J102, pin 2	100 relative units	+10.0 V ± 24 mV	R44

RS-232C Connector Loopback Test

The Communications Setup screen includes a loopback test option for each of the communications ports: J109, J110, and J111. Running the test requires inserting a loopback test connector into each port being tested. (You can test more than one port at a time.)

Making a Loopback Test Connector

Start with an RJ-11C connector and bridge pin 2 (RXD) and pin 5 (TXD) together. Figure 8-6 shows the pinout of a communications port while you face the rear panel of a 120 Series Monitor. Table 8-6 lists the signal description for each pin.

Testing the Port(s)

1. Access the Communications Setup screen (see Figure 8-7).
2. Insert a loopback test connector into each communications port being tested.
3. Set the mode field on the Communications Setup screen to LOOPBACK. Notice that the word OFF displays to the right of the mode.
4. Verify that, after a few seconds, the status LOOPBACK OK displays. OK indicates that the test has passed.

NOTE: If OFF remains displayed, the test has failed; contact your GE Service Representative. Do not use this port to connect to any peripheral equipment until the port or Communications Board has been serviced.

Figure 8-6. RJ-11C Connector

Table 8-6. J109, J110, and J111 Communications Ports Connector Pinout

J109, J110, Or J111 Pin #	Signal Description
1	RTS
2	RXD
3	GND
4	GND

Table 8-6. J109, J110, and J111 Communications Ports Connector Pinout	
J109, J110, Or J111 Pin #	Signal Description
5	TXD
6	CTS

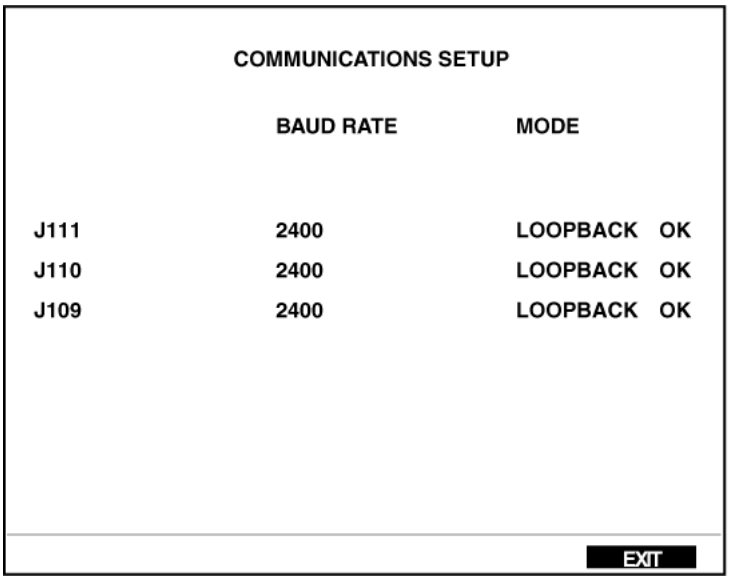


Figure 8-7. Communications Screen

Chapter 9

General Maintenance

All equipment, no matter how reliable, needs to be maintained on a regular basis. This section describes general care and cleaning instructions for the 120 Series Monitor and its accessories.

CAUTION
BEFORE YOU START—Unplug the monitor from the AC power source and detach all accessories from the monitor. Do not immerse accessories in any liquid. Do not use abrasive cloth or cleaners on monitor or accessories.

This chapter describes the following:

Cleaning 9-2
Main Board Battery 9-5
Maternal Blood Pressure Tests. 9-6
Electrical Safety Tests 9-12

Cleaning

The following cleaning instructions are provided. If an accessory is not listed, consult the manufacturer's instructions.

Cleaning the Monitor Exterior

1. Wipe any fluids from the surface of the monitor.
2. Dampen a cloth or paper towel with isopropyl alcohol and gently rub soiled area until clean.

Cleaning the Electroluminescent Panel

1. Dampen a soft cloth with water. The cloth should be free of grit or other particles that may cause abrasion.

> **CAUTION**
> CLEANING AGENTS—Do not use isopropyl alcohol.

2. Rub lightly in a circular motion.

Cleaning the Tocotransducer, Ultrasound Transducer, and MECG Cables

CAUTIONS

ABRASION—Do not use abrasive cloth, sharp objects, or abrasive cleaners.

ALCOHOL—Do not use Alcohol in cleaning solutions.

DISCONNECTION—Detach all transducers and cables from the monitor.

IMMERSION—Only Nautilus Tocotransducers may be immersed. Other transducers and cables may not be immersed or held under running water.

1. Dampen a cloth or paper towel with one of the following products; then wring out until only slightly wet:
   - Sodium Hypochlorite 5.25 % (Bleach) diluted 10:1
   - Cidex
   - Sporicidin
   - Soap and water
2. Rub soiled area until clean, taking care not to excessively wet the tocotransducer diaphragm seal or the contact surface of the ultrasound transducer.
3. Dry with a soft, dry cloth.

Cleaning the UA Strain Gauge

1. Remove the plastic dome.
2. If desired, wash the transducer with sterile water or saline solution.
3. Carefully clean the diaphragm seal with a cotton swab to remove deposits. Avoid excessive pressure since this may damage the diaphragm. If there are excessive stains on the diaphragm or sides of the transducer, remove with a cotton swab and solvents of increasing strength.
4. After cleaning, rinse the transducer thoroughly in distilled water and replace the dome loosely.
5. Dry the transducer with sterile gauze.

CAUTIONS

AUTOCLAVE—Do not autoclave pressure transducer.

IMMERSION—Do not immerse any part of the electrical connector of the transducer in the cleaning solution at any time. Examine the outer sheath of the cable for perforations. If the outer covering is damaged in any way, do not immerse the cable in the cleaning solution; this may result in moisture entering the transducer case, which is vented through the cable.

WARNING

LIQUIDS—If liquids enter the electrical connector, check the resistance between the electrical element and the transducer case. A resistance level of greater than 10 M¾ ensures that the leakage current is within acceptable levels for safe use on patients.

6. Leave transparent dome attached to the transducer during storage, but slacken the locking ring at least one quarter of a turn.

CAUTION

STERILIZATION—Prior to patient use, ensure the dome is sterile.

Cleaning the Maternal NBP Cuffs and Hoses

To clean the pneumatic tubing and cuffs, use a soft cloth dampened with a soap and water solution. Do not immerse hoses or cuffs in liquids.

Main Board Battery

The 120 Series Monitor contains a battery-backed RAM component on the Main Board at U30 (414775-001) which stores default settings when the monitor is turned off. To replace this chip:

1. Turn off the monitor and disconnect the power cord from the monitor.
2. Remove the nine screws which secure the monitor top cover. Four of the screws are located on the bottom of the monitor and five are located in the back.
3. Remove the cover by sliding it towards the rear of the monitor.
4. Remove the hold-down screws securing the NBP Board (14582) to the chassis.
5. Slide the NBP Board out of the card cage, only enough to lay it on top of the front end board cover. Use care not to disconnect the NBP tubes at either end.
6. Use a small screwdriver to remove U30 from the socket on the Main Board.

CAUTION
BATTERY DISPOSAL—Follow the battery manufacturer's recommendations or your hospital policy for the handling and disposal of used batteries.

7. Snap the new battery chip into place. (No special tools are required.)
8. Reconnect the NBP Board to and secure with both hold-down screws. Ensure that the blood pressure tubes remain secured in the notch on top of the DSP Board.
9. Replace the monitor top cover and secure all nine screws.
10. Re-connect the power cord and turn on the monitor.

Maternal Blood Pressure Tests

Accessing the Diagnostic Control Screen

The manometer and pneumatic pressure tests are initiated from one of several service screens:

1. Select the SETUP softkey from the main operating screen to display the General Setup screen (Figure 9-1).
2. Select the SERVICE softkey from the General Setup screen to display the Service Lock screen (Figure 9-2). The access code is displayed as 0 0 0 0.

NOTE: The correct date and time must be set on the General Setup screen or you will not gain access to the service screens.

3. Use the Trim Knob control to set the access code to the current month and date. You can enter the date followed by the month; or the month followed by the date. For example: February 21 can be entered as 0 2 2 1 or 2 1 0 2.
4. As soon as you enter the correct access code, the Install Options screen displays (Figure 9-3).

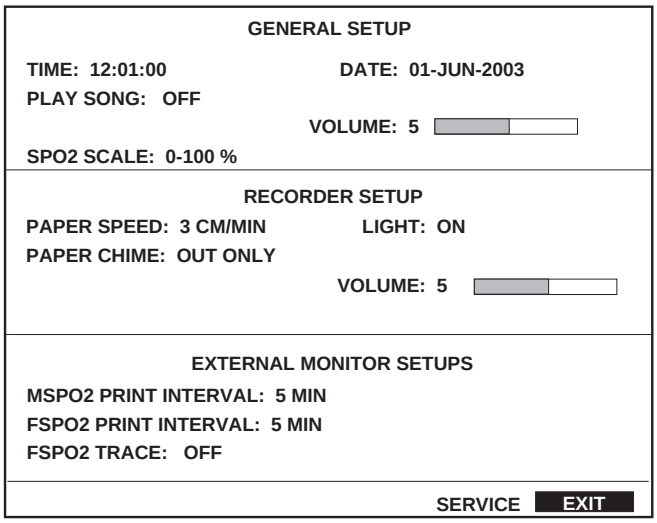


Figure 9-1. General Setup Screen

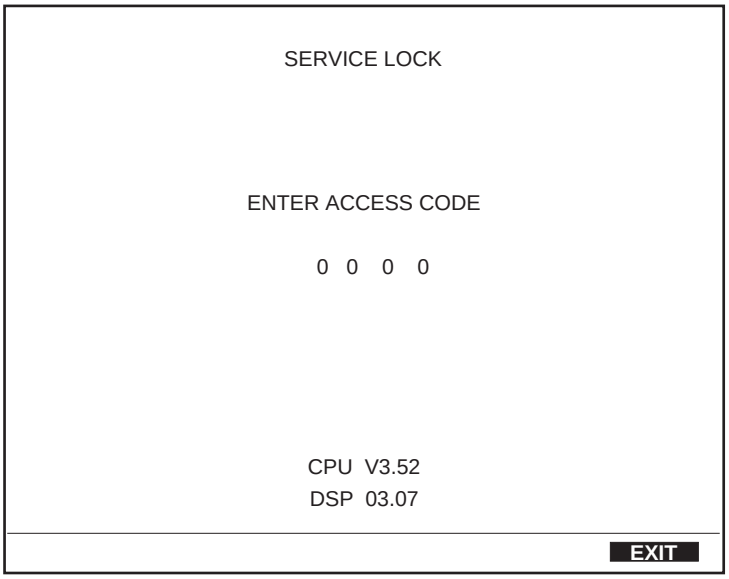


Figure 9-2. Service Lock Screen

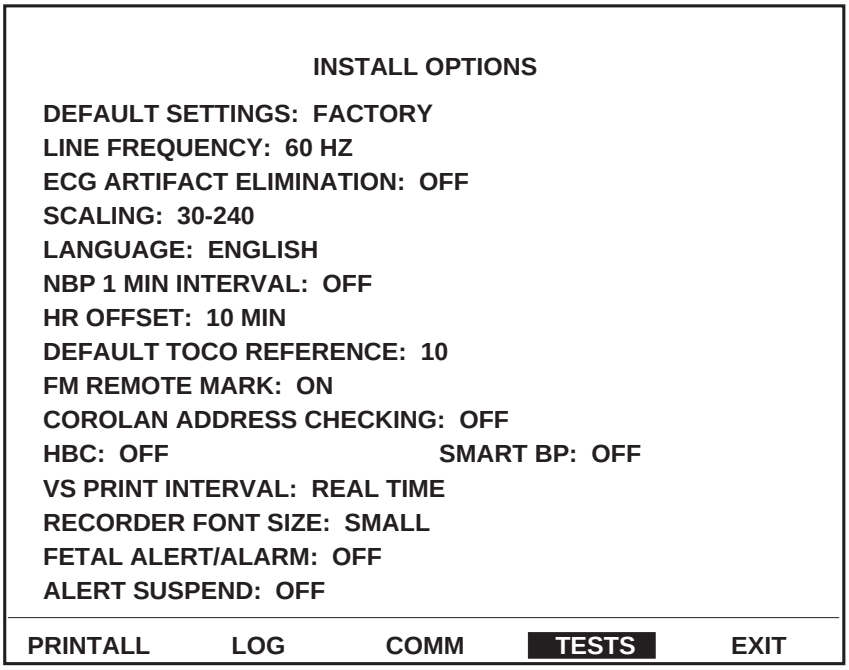


Figure 9-3. Install Options Screen

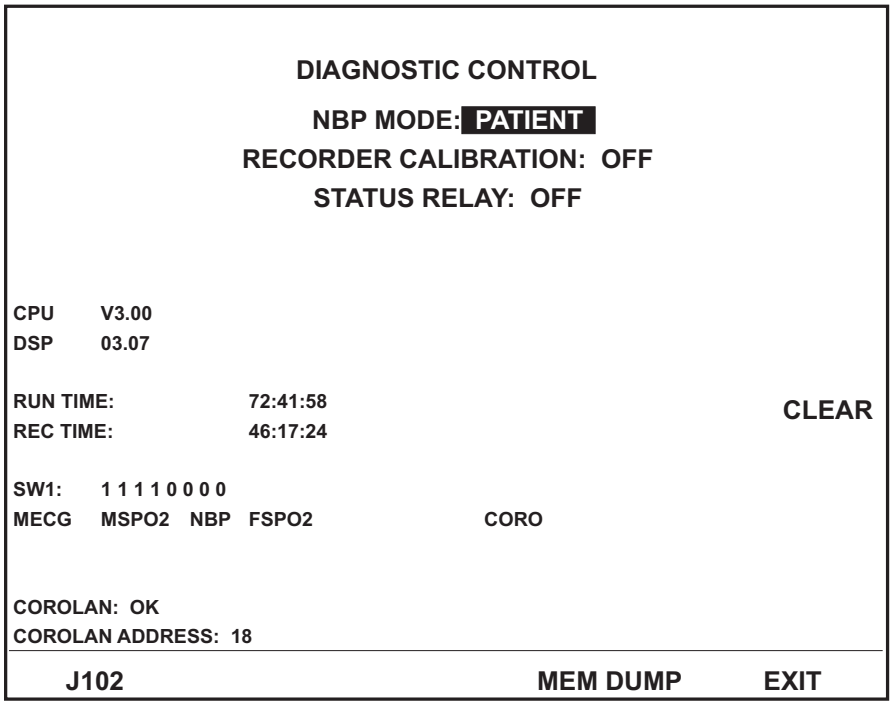


Figure 9-4. Diagnostic Control Screen

Manometer Pressure Check

This test is used to perform a calibration check of the internal blood pressure module. This test should be performed annually by a qualified service person. The following equipment is required in order to perform the test:

- Mercury manometer with a range of 300 mmHg minimum; or digital pressure gauge
- Inflation hand bulb
- Corometrics standard hose with a female Luer fitting for a single-tube cuff—the cuff should be removed
- T-connector with a male Luer fitting (remaining fittings dependent upon manometer and hand bulb

1. Attach the connector end of the pneumatic hose to the Maternal BP connector on the 120 Series Monitor.
2. Attach a T-connector with a male Luer fitting to the cuff end of the pneumatic hose.
3. Connect the appropriate end of the T-connector to the inflation bulb.
4. Connect the remaining end of the T-connector to the manometer tubing.
5. Use the Trim Knob control to set the NBP mode on the Diagnostic Control service mode screen to MANOMETER.
6. Verify that the cuff pressure in the NBP display area is 0 mmHg.
7. Using the inflation bulb, manually pump up the pressure to 200 mmHg ± 1 mmHg, as indicated by the manometer. Verify that the monitor displays a pressure reading of 200 mmHg ± 5 mmHg.
8. Hold the pressure at 200 mmHg for 30 seconds and verify that the pressure indicated by the monitor does not change. If the monitor is unable to hold the pressure for the test period, deflate the pressure to 0 mmHg, check the assembly of the calibration equipment, and repeat the test procedure. If the monitor fails to hold the pressure a second time, contact your Service Representative.
9. Repeat step 7 using the pressure levels indicated in Table 9-1. If the pressure levels are not within tolerance, contact your Service Representative.

10. Slowly inflate the manometer, using the inflation hand bulb, to 285 mmHg ± 15 mmHg. Verify that the OVERPRESSURE message displays.

WARNING
OVERPRESSURE—If the overpressure message is not indicated, or if the overpressure reading is not within the specified tolerance, contact your Service Representative. Do not use this monitor to perform blood pressure readings until the problem is corrected.

11. Access the Diagnostic Control service mode screen and configure the NBP mode to PATIENT.

Table 9-1. Calibration Check Pressure Levels

MAnometer Pressure Level	120 Series Monitor Pressure Level
0 mmHg + 1 mmHg	0 mmHg + 1 mmHg
50 mmHg ± 1 mmHg	50 mmHg ± 4 mmHg
100 mmHg ± 1 mmHg	100 mmHg ± 4 mmHg
150 mmHg ± 1 mmHg	150 mmHg ± 4 mmHg
200 mmHg ± 1 mmHg	200 mmHg ± 5 mmHg

Pneumatic Pressure Check

This procedure provides a pneumatic test of the monitor's internal blood pressure module. This test should be performed annually by a qualified Service Representative. The following equipment is required to perform this test:

- Corometrics standard hose with a female Luer fitting for a single-tube cuffs—the cuff should be removed
- Male Luer plug.

1. Plug the male Luer plug into the cuff connector at the end of the pneumatic tubing and twist one quarter turn. Ensure that the plug is securely connected.
2. Use the Trim Knob control to set the NBP mode on the Diagnostic Control service mode screen to PNEUMATIC.
3. You will hear the motor running and see the cuff inflation value in the NBP area of the display. If the test passes, the cuff deflates and the NBP area is blank. If the test fails, you will see one of the following messages: REPAIR, CHECK CUFF, LEAK, OVERPRESSURE, MOTION, OR WEAK SIGNAL.

WARNING
If the monitor fails the pneumatic test, check hoses and fitting and try the test again. If the monitor fails the test a second time, contact your Service Representative. Do not use the monitor to perform blood pressure readings until the problem is corrected.

4. Access the Diagnostic Control service mode screen and configure the NBP mode to PATIENT.

Electrical Safety Tests

Perform all electrical safety tests in this section.

IMPORTANT
UNITS OF MEASURE—The specified leakage tester (E278-06) measures in mV. There is a direct correlation of mV to μA. In other words, on this text fixture, 1 mV = 1 μA.

IMPORTANT
220/230/240 VAC POWER CORD—For 220/230/240 VAC testing, use only P/N 600034 line cord to power the E278-06 test fixture.

Initial Conditions

1. Attach the monitor power cord to the leakage test fixture.
2. Verify that the leakage test fixture's main AC power cord is attached.

AC Line

☐ Voltage measurement from 100–240 V.

Ground Impedance

☐ < 300 mΩ, lead to rear panel equipotential ground lug

☐ < 300 mΩ, lead to top cover bezel screw

Unit to Primary Leakage

1. Set the fixture's Leakage switch to Unit.
2. Turn ON the monitor using the monitor's power switch.
3. Verify the following:

   ☐ < 300 μA (100, 120, 220, 230, or 240 VAC monitors)

4. Record the primary leakage for the following conditions:

Table 9-2. Unit to Primary Leakage Conditions

Neutral	Ground	Power (Polarity)
_____ Closed	_____ Closed	_____ Normal
_____ Closed	_____ Open	_____ Normal
_____ Closed	_____ Open	_____ Reversed
_____ Closed	_____ Closed	_____ Reversed
_____ Open	_____ Closed	_____ Normal
_____ Open	_____ Open	_____ Normal
_____ Open	_____ Open	_____ Reversed
_____ Open	_____ Closed	_____ Reversed

Patient-to-Ground Leakage for ECG

1. Connect an ECG test body to the monitor's front panel ECG input. The ECG test body can be shorted MECG cable, or the assembly leakage cable.

IMPORTANT
TEST CABLES—If you use transducers in lieu of the assembly leakage cable, and you are testing a Model 129/129F Monitor, you must test both FECG and MECG.

2. Set the fixture's Leakage switch to Patient.
3. Turn ON the monitor using the monitor's power switch.
4. Verify the following:

   ☐ < 50 μA (100, 120, 220, 230, or 240 VAC monitors)

5. Record the patient-to-ground leakage for the following conditions:

Table 9-3. Patient-to-Ground Leakage Conditions for ECG

Neutral	Ground	Power (Polarity)
_____ Closed	_____ Closed	_____ Normal
_____ Closed	_____ Open	_____ Normal
_____ Closed	_____ Open	_____ Reversed
_____ Closed	_____ Closed	_____ Reversed
_____ Open	_____ Closed	_____ Normal
_____ Open	_____ Closed	_____ Reversed

Patient-to-Line Leakage for ECG

1. Connect an ECG test body to the monitor's front panel ECG input. The ECG test body can be the assembly leakage cable.
2. Set the fixture's Leakage switch to Line.
3. Turn ON the monitor using the monitor's power switch.
4. Verify the following:

   ☐ < 50 μA (100, 120, 220, 230, or 240 VAC monitors)

5. Record the patient-to-ground leakage for the following conditions:

Table 9-4. Patient-to-Line Leakage Conditions for ECG

Neutral	Ground	Power (Polarity)
_____ Closed	_____ Closed	_____ Normal
_____ Closed	_____ Closed	_____ Reversed
_____ Open	_____ Closed	_____ Normal
_____ Open	_____ Closed	_____ Reversed

Patient-to-Ground Leakage for IUP

1. Connect an IUP test body to the monitor's front panel UA input. The IUP test body can be a SensorTip transducer (wrapped in aluminum foil) or the assembly leakage cable.
2. Set the fixture's Leakage switch to Patient.
3. Turn ON the monitor using the monitor's power switch.
4. Verify the following:

   ☐ < 50 μA (100, 120, 220, 230, or 240 VAC monitors)

5. Record the patient-to-ground leakage for the following conditions:

Table 9-5. Patient-to-Ground Leakage Conditions for IUP

Neutral	Ground	Power (Polarity)
_____ Closed	_____ Closed	_____ Normal
_____ Closed	_____ Open	_____ Normal
_____ Closed	_____ Open	_____ Reversed
_____ Closed	_____ Closed	_____ Reversed
_____ Open	_____ Closed	_____ Normal
_____ Open	_____ Closed	_____ Reversed

Patient-to-Line Leakage for IUP

1. Connect an IUP test body to the monitor's front panel UA input. The IUP test body can be a SensorTip transducer (wrapped in aluminum foil) or the assembly leakage cable.
2. Set the fixture's Leakage switch to Line.
3. Turn ON the monitor using the monitor's power switch.
4. Verify the following:

   ☐ < 50 μA (100, 120, 220, 230, or 240 VAC monitors)

5. Record the patient-to-ground leakage for the following conditions:

Table 9-6. Patient-to-Line Leakage Conditions for IUP

Neutral	Ground	Power (Polarity)
_____ Closed	_____ Closed	_____ Normal
_____ Closed	_____ Closed	_____ Reversed
_____ Open	_____ Closed	_____ Normal
_____ Open	_____ Closed	_____ Reversed

Patient-to-Ground Leakage for $MSpO_2$

1. Connect an $MSpO_2$ test body to the monitor's front panel $MSpO_2$ input. Use the assembly leakage cable for the test body.
2. Set the fixture's Leakage switch to Patient.
3. Turn ON the monitor using the monitor's power switch.
4. Verify the following:

   ☐ < 50 μA (100, 120, 220, 230, or 240 VAC monitors)

5. Record the patient-to-ground leakage for the following conditions:

Table 9-7. Patient-to-Ground Leakage Conditions for $MSpO_2$

Neutral	Ground	Power (Polarity)
_____ Closed	_____ Closed	_____ Normal
_____ Closed	_____ Open	_____ Normal
_____ Closed	_____ Open	_____ Reversed
_____ Closed	_____ Closed	_____ Reversed
_____ Open	_____ Closed	_____ Normal
_____ Open	_____ Closed	_____ Reversed

Patient-to-Line Leakage for $MSpO_2$

1. Connect an $MSpO_2$ test body to the monitor's front panel $MSpO_2$ input. Use the assembly leakage cable for the test body.
2. Set the fixture's Leakage switch to Line.
3. Turn ON the monitor using the monitor's power switch.
4. Verify the following:

   ☐ < 50 μA (100, 120, 220, 230, or 240 VAC monitors)

5. Record the patient-to-ground leakage for the following conditions:

Table 9-8. Patient-to-Line Leakage Conditions for $MSpO_2$

Neutral	Ground	Power (Polarity)
_____ Closed	_____ Closed	_____ Normal
_____ Closed	_____ Closed	_____ Reversed
_____ Open	_____ Closed	_____ Normal
_____ Open	_____ Closed	_____ Reversed

Patient-to-Ground Leakage for $FSpO_2$

1. Connect an $FSpO_2$ test body to the monitor's front panel $FSpO_2$ input. Use the assembly leakage cable for the test body.
2. Set the fixture's Leakage switch to Patient.
3. Turn ON the monitor using the monitor's power switch.
4. Verify the following:

   ☐ < 50 μA (100, 120, 220, 230, or 240 VAC monitors)

5. Record the patient-to-ground leakage for the following conditions:

Table 9-9. Patient-to-Ground Leakage Conditions for $FSpO_2$

Neutral	Ground	Power (Polarity)
_____ Closed	_____ Closed	_____ Normal
_____ Closed	_____ Open	_____ Normal
_____ Closed	_____ Open	_____ Reversed
_____ Closed	_____ Closed	_____ Reversed
_____ Open	_____ Closed	_____ Normal
_____ Open	_____ Closed	_____ Reversed

Patient-to-Line Leakage for $FSpO_2$

1. Connect an $FSpO_2$ test body to the monitor's front panel $FSpO_2$ input. Use the assembly leakage cable for the test body.
2. Set the fixture's Leakage switch to Line.
3. Turn ON the monitor using the monitor's power switch.
4. Verify the following:

   ☐ < 50 μA (100, 120, 220, 230, or 240 VAC monitors)

5. Record the patient-to-ground leakage for the following conditions:

Table 9-10. Patient-to-Line Leakage Conditions for $FspO_2$

Neutral	Ground	Power (Polarity)
_____ Closed	_____ Closed	_____ Normal
_____ Closed	_____ Closed	_____ Reversed
_____ Open	_____ Closed	_____ Normal
_____ Open	_____ Closed	_____ Reversed

Patient-to-Ground Leakage for US

1. Connect an US test body to the monitor's front panel US input. The US test body should be an ultrasound transducer wrapped in aluminum foil.
2. Set the fixture's Leakage switch to Patient.
3. Turn ON the monitor using the monitor's power switch.
4. Verify the following:

   ☐ < 50 μA (100, 120, 220, 230, or 240 VAC monitors)

5. Record the patient-to-ground leakage for the following conditions:

Table 9-11. Patient-to-Ground Leakage Conditions for US

Neutral	Ground	Power (Polarity)
_____ Closed	_____ Closed	_____ Normal
_____ Closed	_____ Open	_____ Normal
_____ Closed	_____ Open	_____ Reversed
_____ Closed	_____ Closed	_____ Reversed
_____ Open	_____ Closed	_____ Normal
_____ Open	_____ Closed	_____ Reversed

Patient-to-Line Leakage for US

1. Connect an US test body to the monitor's front panel US input. The US test body should be an ultrasound transducer wrapped in aluminum foil.
2. Set the fixture's Leakage switch to Line.
3. Turn ON the monitor using the monitor's power switch.
4. Verify the following:

   ☐ < 50 μA (100, 120, 220, 230, or 240 VAC monitors)

5. Record the patient-to-ground leakage for the following conditions:

Table 9-12. Patient-to-Line Leakage Conditions for US

Neutral	Ground	Power (Polarity)
_____ Closed	_____ Closed	_____ Normal
_____ Closed	_____ Closed	_____ Reversed
_____ Open	_____ Closed	_____ Normal
_____ Open	_____ Closed	_____ Reversed

Patient-to-Ground Leakage for US2

1. Connect an US test body to the monitor's front panel US2 input. The US test body should be an ultrasound transducer wrapped in aluminum foil.
2. Set the fixture's Leakage switch to Patient.
3. Turn ON the monitor using the monitor's power switch.
4. Verify the following:

   ☐ < 50 μA (100, 120, 220, 230, or 240 VAC monitors)

5. Record the patient-to-ground leakage for the following conditions:

Table 9-13. Patient-to-Ground Leakage Conditions for US2

Neutral	Ground	Power (Polarity)
_____ Closed	_____ Closed	_____ Normal
_____ Closed	_____ Open	_____ Normal
_____ Closed	_____ Open	_____ Reversed
_____ Closed	_____ Closed	_____ Reversed
_____ Open	_____ Closed	_____ Normal
_____ Open	_____ Closed	_____ Reversed

Patient-to-Line Leakage for US2

1. Connect an US test body to the monitor's front panel US2 input. The US test body should be an ultrasound transducer wrapped in aluminum foil.
2. Set the fixture's Leakage switch to Line.
3. Turn ON the monitor using the monitor's power switch.
4. Verify the following:

   ☐ < 50 μA (100, 120, 220, 230, or 240 VAC monitors)

5. Record the patient-to-ground leakage for the following conditions:

Table 9-14. Patient-to-Line Leakage Conditions for US2

Neutral	Ground	Power (Polarity)
_____ Closed	_____ Closed	_____ Normal
_____ Closed	_____ Closed	_____ Reversed
_____ Open	_____ Closed	_____ Normal
_____ Open	_____ Closed	_____ Reversed

Ground Continuity

☐ Use an ohmmeter to confirm continuity between the monitor's AC receptacle inlet ground pin and the unit's chassis.

Dielectric (Hi-Pot) Tests

CAUTION
POWER OFF—Turn OFF the monitor prior to performing any of the hi-pot tests.

Patient–to–AC-Line Using DC Voltage for One Minute

Connect the monitor to the hi-pot tester as shown in Figure 9-5.

NOTE: The hi-pot tester voltage is 5.656 kVdc.

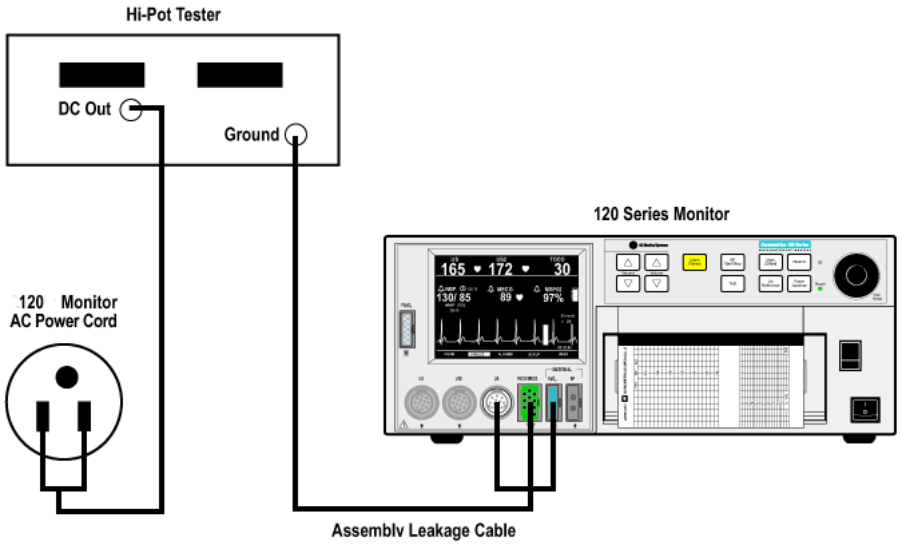


Figure 9-5. Patient–to–AC-Line Using DC Voltage for One Minute (5.656 kVdc)

- **FECG:** Connect an FECG test body to the monitor's front panel ECG input. The FECG test body can be the assembly leakage cable. Measure the voltage breakdown.

  ☐ pass ☐ fail

- **MECG:** Connect an ECG test body to the monitor's front panel ECG input. The MECG test body can be a shorted MECG cable or the assembly leakage cable. Measure the voltage breakdown.

  ☐ pass ☐ fail

- **IUP:** Connect an IUP test body to the monitor's front panel UA input. The IUP test body can be a SensorTip cable (wrapped in aluminum foil) or the assembly leakage cable. Measure the voltage breakdown.

  ☐ pass ☐ fail

- **MSpO$_2$:** Connect an MSpO$_2$ test body to the monitor's front panel MSpO$_2$ input. The MSpO$_2$ test body can be a MSpO$_2$ cable and sensor (wrapped in aluminum foil) or the assembly leakage cable. Measure the voltage breakdown.

  ☐ pass ☐ fail

- **FSpO$_2$:** Connect an FSpO$_2$ test body to the monitor's front panel FSpO$_2$ input. The FSpO$_2$ test body should be an FSpO$_2$ cable and sensor wrapped in aluminum foil. Measure the voltage breakdown.

  ☐ pass ☐ fail

- **US:** Connect an US test body to the monitor's front panel US input. The US test body should be an ultrasound transducer wrapped in aluminum foil. Measure the voltage breakdown.

  ☐ pass ☐ fail

- **US2:** Connect an US test body to the monitor's front panel US2 input. The US test body should be an ultrasound transducer wrapped in aluminum foil. Measure the voltage breakdown.

  ☐ pass ☐ fail

Patient–to–Chassis Using AC Voltage for One Minute

Connect the monitor to the hi-pot tester as shown in Figure 9-6.

NOTE: The hi-pot tester voltage is 2.5 kVAC.

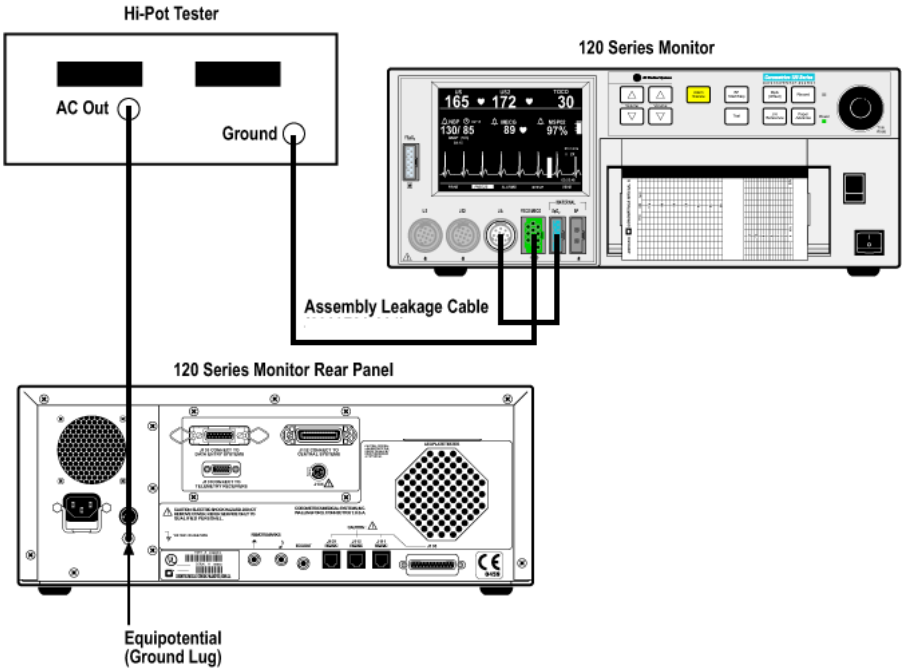


Figure 9-6. Patient–to–Chassis Using AC Voltage for One Minute (2.5 kVAC)

- **FECG:** Connect an FECG test body to the monitor's front panel ECG input. The FECG test body can be the assembly leakage cable. Measure the voltage breakdown.

  ☐ pass ☐ fail

- **MECG:** Connect an ECG test body to the monitor's front panel ECG input. The MECG test body can be a shorted MECG cable or the assembly leakage cable. Measure the voltage breakdown.

  ☐ pass ☐ fail

- **IUP:** Connect an IUP test body to the monitor's front panel UA input. The IUP test body can be a SensorTip cable (wrapped in aluminum foil) or the assembly leakage cable. Measure the voltage breakdown.

  ☐ pass ☐ fail

- **MSpO$_2$:** Connect an MSpO$_2$ test body to the monitor's front panel MSpO$_2$ input. The MSpO$_2$ test body can be a MSpO$_2$ cable and sensor (wrapped in aluminum foil) or the assembly leakage cable. Measure the voltage breakdown.

  ☐ pass ☐ fail

- **FSpO$_2$:** Connect an FSpO$_2$ test body to the monitor's front panel FSpO$_2$ input. The FSpO$_2$ test body should be an FSpO$_2$ cable and sensor wrapped in aluminum foil. Measure the voltage breakdown.

☐ pass ☐ fail

- **US:** Connect an US test body to the monitor's front panel US input. The US test body should be an ultrasound transducer wrapped in aluminum foil. Measure the voltage breakdown.

  ☐ pass ☐ fail

- **US2:** Connect an US test body to the monitor's front panel US2 input. The US test body should be an ultrasound transducer wrapped in aluminum foil. Measure the voltage breakdown.

  ☐ pass ☐ fail

Mains–to–Chassis Using DC Voltage for One Minute

Connect the monitor to the hi-pot tester as shown in Figure 9-7.

NOTE: The hi-pot tester voltage is 2.121 kVdc.

☐ pass ☐ fail

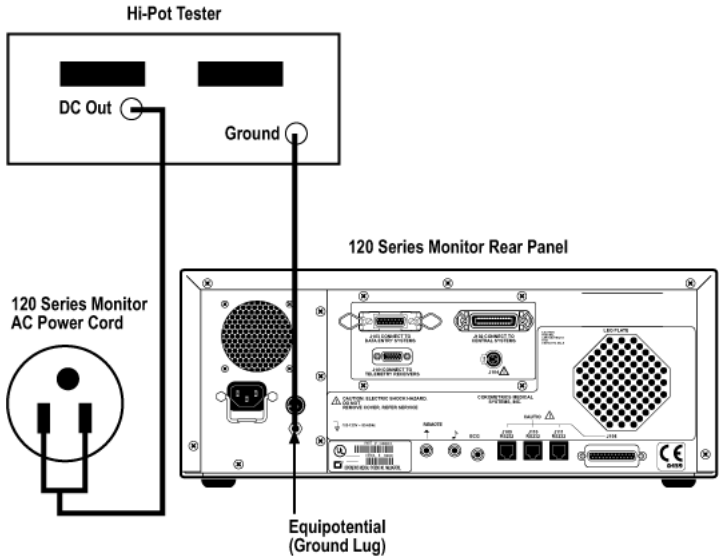


Figure 9-7. Mains–to–Chassis Using DC Voltage for One Minute (2.121 kVdc)

For your notes

Chapter 10

Strip Chart Recorder Servicing

This section of the manual provides information which will aid the biomedical engineer in performing routine service and maintenance on the 120 Series strip chart recorder. This section of the manual is not intended as a substitute for proper professional training, or familiarity with the 120 Series Monitor. Only qualified service personnel should attempt servicing a 120 Series Monitor.

This chapter contains the following information:

Removing the Strip Chart Recorder 10-2
Installing the Strip Chart Recorder. 10-3
Periodic Thermal Printhead Cleaning 10-4
Field Serviceable Assemblies. 10-5

Removing the Strip Chart Recorder

Removing the strip chart recorder requires *loosening* the monitor's front panel bezel. Following this procedure carefully will avoid unnecessary damage to bezel's mounting screws and the unit's front panel connectors.

1. Turn off the 120 Series Monitor and disconnect the power cord from the monitor.
2. Remove the nine screws which secure the monitor top cover. Four screws are located on the bottom of the monitor and five screws are located in the back.
3. Remove the cover by sliding it toward the rear of the monitor.
4. Remove the copper grounding strips from the top of the front bezel to prevent damage when removing the recorder.
5. Remove the two screws on the bottom of the monitor which fasten the strip chart recorder.
6. Remove the two screws which fasten the right side of the front bezel to the monitor. Loosen the two at the left just enough to pull the right side of the bezel away from the chassis.
7. Disconnect the display ribbon cable from the DSP Board at J5.
8. Disconnect the ribbon cable from the membrane switch panel. Leave the other end connected to the DSP Board.
9. Disconnect the ribbon cable from the Recorder Board at J2. Leave the other end connected to the Main Motherboard.
10. Disconnect the Power Supply cable harness from the Recorder Board at J1.
11. Remove the four front recorder mounting screws which secure the frame to the front bezel.
12. Slide the recorder slightly toward the rear of the monitor and then lift the recorder out.

Installing the Strip Chart Recorder

1. Carefully place the recorder into the monitor housing.
2. Install the four front recorder mounting screws which secure the frame to the bezel.
3. Re-connect the Power Supply cable harness to the Recorder Board at J1.
4. Re-connect the Main Motherboard ribbon cable to the Recorder Board at J2.
5. Re-connect the DSP ribbon cable to the membrane switch panel.
6. Re-connect the display ribbon cable to the DSP Board at J5.
7. Carefully reposition the front bezel. Secure all four screws.
8. Install the two screws which secure the recorder to the bottom panel.
9. Replace the copper grounding strips at the top of the front bezel. Be careful not to damage any of the fingers.
10. Replace the monitor top cover and secure with all nine screws.

Periodic Thermal Printhead Cleaning

The thermal printhead heater elements must be cleaned at regular intervals to remove any accumulated paper dust. The heater elements may be cleaned with methanol or isopropyl alcohol. Care must be taken to avoid touching the heater elements with bare hands.

CAUTION
AIR DRYING—Allow to air dry completely prior to using the monitor.

Field Serviceable Assemblies

Disassembly and/or replacement of most recorder parts normally requires the use of special gauges and fixtures to ensure critical tolerances are satisfied; this includes drive roller assemblies. Therefore, field replacement is not recommended and field servicing is limited to the following recorder subassemblies:

- Stepper Motor and Harness
- Printhead
- Paper-Low Photosensor
- Paper-Out Photosensor
- Paper-Loading Photosensor

CAUTION
PRINTHEAD FAILURE—If a sudden or complete failure of the printhead occurs, the exact cause must be diagnosed accurately and corrected prior to installation of a new printhead.

Servicing of any recorder parts, other than the five subassemblies outlined above, should be referred to the nearest GE Service Representative.

Stepper Motor and Harness

Prior to removing/replacing the stepper motor, follow all instructions in the section, "Removing the Strip Chart Recorder".

Removing the Stepper Motor

1. Disconnect the stepper motor harness cable from the Recorder Board at J4.
2. Loosen the two screws attaching the motor to the frame.
3. Slide the stepper motor sideways to the right and lift out.

Replacing the Stepper Motor

1. Slide new stepper motor into place.
2. Replace the two screws which attach the motor to the frame.
3. Re-connect the stepper motor harness cable to the Recorder Board at J4.

Printhead Adjustments

Refer to Figure 10-1 and Figure 10-2 for identification of the adjustment points outlined in this section, and to assist in clarifying adjustment procedures. Figure 10-1 and Figure 10-2 show top and right side views of the 120 Series Monitor strip chart recorder assembly removed from the unit's chassis.

Table 10-1 gives a description of each recorder adjustment. Adjustments C through F can be performed without removing recorder from unit's chassis; however, they require removing the monitor's top cover.

The printhead may require performing one or both of the following offset adjustment procedures.

Vertical Offset Adjustment

To check vertical offset alignment, run at least two monitor self-tests by depressing the front panel **Test** pushbutton. The first horizontal trace should be printed 0.490 ± 0.002 inch from the right hand paper guide. (Refer to Figure 10-3.) Perform the following steps if the trace does not fall within the specified offset range.

1. Loosen the two set screws labeled **A** in Figure 10-1.
2. Adjust hex-head screw labeled **C** in Figure 10-2, until test trace falls within specified tolerance.
3. Tighten the two set screws labeled **A**.

Horizontal Offset Adjustment

Adjust the horizontal offset if any of the following symptoms are detected. If skewing occurs, check for other malfunctions. Noticeable skewing of a vertical line printed on the strip chart paper is usually accompanied by one of the following symptoms:

- Paper consistently curls to one side.
- Printing of unequal weight occurs along the vertical trace line, from one end to the other.
- Dots are missing along the vertical trace.
- Printing is too light following printhead replacement.

If the Horizontal Offset Adjustment is required, perform the following steps:

1. Loosen the four hex-head lock screws—two on each side. The right side screws are labeled **B** in Figure 10-2.
2. To move the printhead forward on one side, back-off the corresponding captive screw (turn counterclockwise) from its alignment block. To move the printhead backward on one side, tighten the corresponding captive screw (turn clockwise).
3. After making the necessary adjustments, tighten the four hex-head lock screws labeled **B**.

Table 10-1. Printhead Adjustments	
Adjustment	Description
A	Set screws loosened to perform a vertical offset adjustment.
B	Hex-head screw loosened to perform a horizontal offset adjustment.
C	Hex-head screw which determines the vertical offset of a horizontal line. (See Figure 10-3.)
D	Captive hex-head screw which controls the horizontal offset of a vertical line on the top grid of the strip chart paper (heart rate channel).
E	Captive hex-head screw which controls the horizontal offset of a vertical line on the bottom grid of the strip chart paper (uterine pressure channel).

Thermal Printhead

The thermal printhead is a part of the printhead assembly. Refer to the parts list in "Chapter 16, Assembly Drawings and Parts Lists", of this manual for ordering information and illustrations showing the printhead assembly.

Removing the Printhead

Use the following procedure for removing the 120 Series Monitor printhead. As long as you have a short screwdriver, you will not need to remove the strip chart recorder from the monitor.

1. Turn off the 120 Series Monitor and disconnect the power cord from the monitor.
2. Remove the nine screws which secure the monitor top cover. Four screws are located on the bottom of the monitor and five screws are located in the back.
3. Remove the cover by sliding it toward the rear of the monitor.
4. Disconnect the printhead harness cable from J3 on the Recorder Board.
5. Open the recorder door.
6. Support the printhead by reaching in through the recorder door, then remove the two screws on top of the printhead.
7. Pull the printhead down and out through the recorder door with the harness still attached.

NOTE: If you are familiar with other Corometrics monitors, be assured that the four pressure springs are held captive and will not fall out.

8. Remove the harness cable from the printhead and retain for use with replacement printhead.

Replacing the Printhead

Use the following procedure for installing a 120 Series Monitor printhead:

1. Turn off the 120 Series Monitor and disconnect the power cord from the monitor.
2. Carefully remove the new printhead from the packaging; do not touch any of the contact pins. Record the voltage rating marked on the decal affixed to the bottom of the printhead. This value is the VHEAD voltage. The voltage rating should be marked over the old voltage rating on the printhead bracket.
3. Re-connect the harness cable to the printhead.
4. Slide the new printhead into position through the recorder door and under its bracket. Push on the center of the printhead to ensure it is pushed all the way back.
5. Align the printhead with the front holes in the bracket and replace the two screws.
6. Re-connect the harness cable to the Recorder Board at J3.
7. Connect the positive lead of a voltmeter to TP1 on the Recorder Board; connect the negative lead to TP2.
8. Re-connect the monitor power cord and then turn on the monitor.

9. Press the **Record** pushbutton to turn on the recorder.
10. Adjust R2 on the Recorder Board until the reading on the digital voltmeter is within ±100 mV of the VHEAD voltage stamped on the printhead.
11. Access the Diagnostic Control service mode screen and run the recorder test to check the printing of vertical lines. (Refer to "Chapter 8, Self-Tests".) If light printing occurs, refer to the instructions under "Horizontal Offset Adjustment" on page 10-6.
12. Replace the top cover and secure all nine screws.

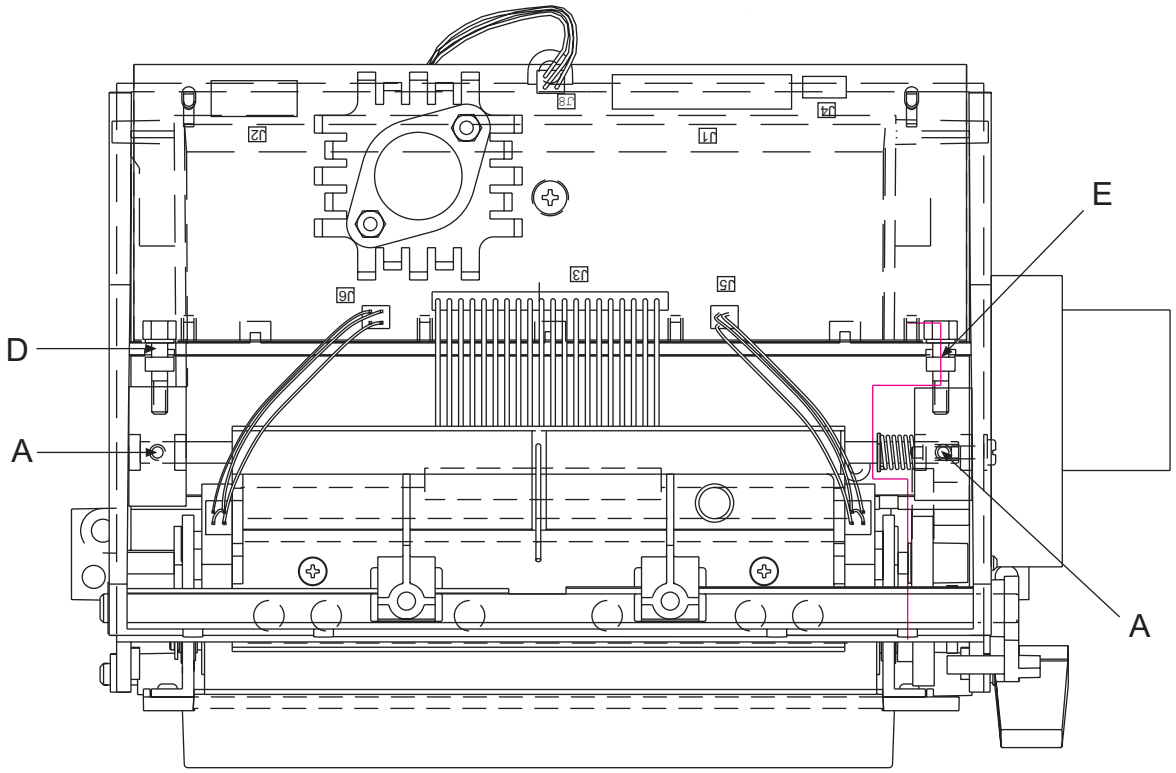


Figure 10-1. Recorder Top View

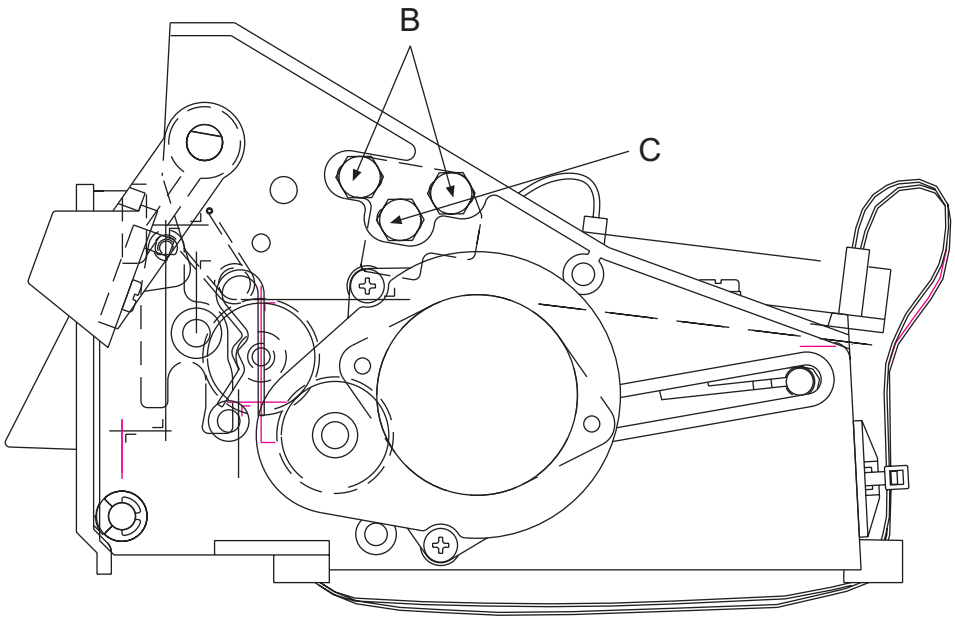


Figure 10-2. Recorder Right Side View

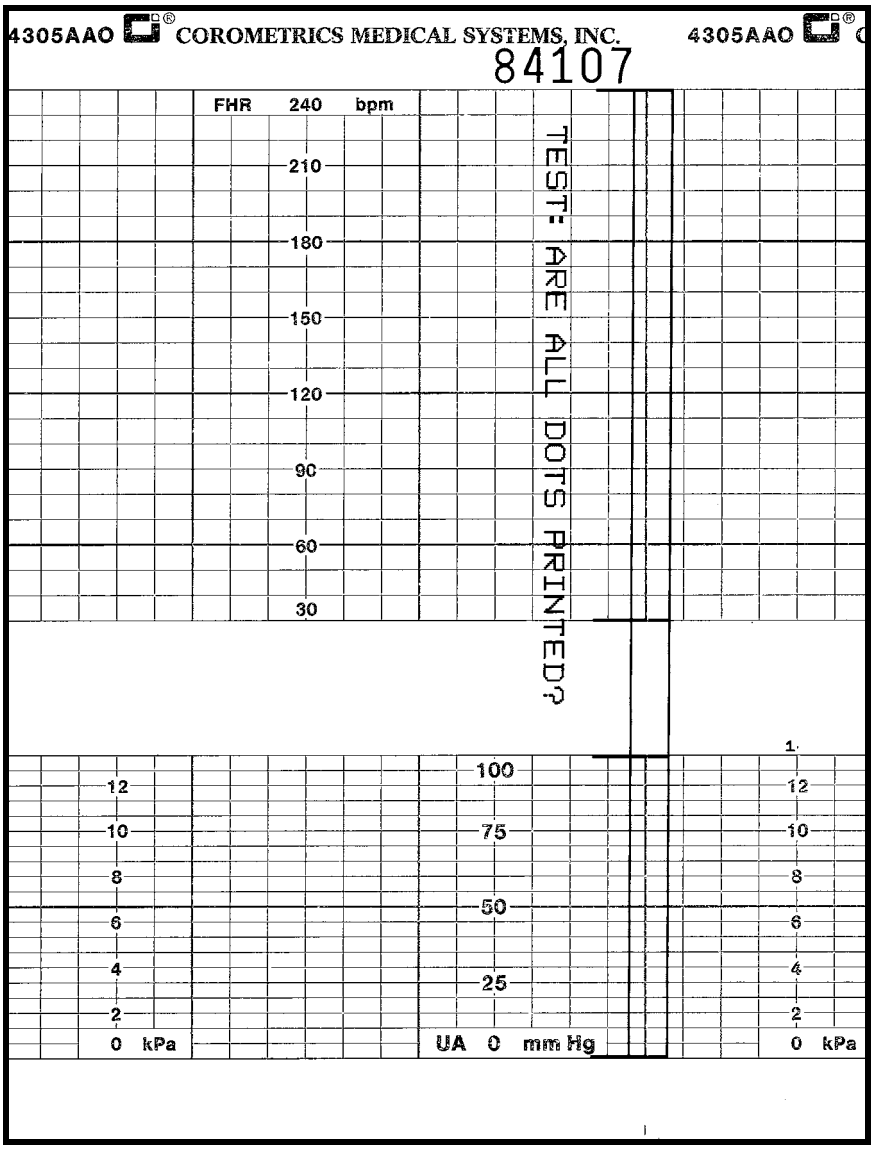


Figure 10-3. Vertical Offset Adjustment Self-Test Trace

Paper-Low/Paper-Out Photosensor

Although these two reflective-sensors may be replaced in the field, tight tolerance repositioning is required to ensure that the sensors function properly. Therefore, it is recommended that the photosensors be replaced by a GE Service Representative. If the replacement is done locally, it must be done according to the following procedure.

NOTE: When facing the front of the monitor: the paper-low sensor is on the right side; the paper-out sensor is on the left side.

Removing the Paper-Low/Paper-Out Photosensor

Use the following procedure for removing the paper-low or paper-out photosensor.

1. Turn off the 120 Series Monitor and disconnect the power cord from the monitor.
2. Remove the nine screws which secure the monitor top cover. Four screws are located on the bottom of the monitor and five are located in the back.
3. Remove the cover by sliding it toward the rear of the monitor.
4. Disconnect the respective sensor cable from the black sensor housing. Record the orientation of the connector for replacement later.
5. Using an allen wrench, remove the two socket-head screws which attach the black sensor housing to the angle bracket.
6. Discard the sensor and housing.

Replacing the Paper-Low/Paper-Out Photosensor

Use the following procedure for replacing the paper-low or paper-out photosensor:

1. Attach the sensor and housing to the printhead support bracket using the two socket-head screws. Ensure that the black sensor housing is parallel with the top of the printhead bracket before tightening the screws.
2. Re-connect the sensor cable using the correct orientation.
3. Adjust the respective sensor as described next in this section.
4. Replace the monitor top cover and secure with all nine screws.

Adjusting the Paper-Low Photosensor

1. Load paper in the recorder. Ensure that there are *no* black squares showing to indicate a paper-low condition.
2. If you haven't already, re-connect the power cord and turn on the monitor.
3. Press the **Record** button to turn on the recorder. Allow the paper to advance for a few seconds in order to tension the paper.
4. Turn off the recorder.
5. Using a digital voltmeter, connect the positive lead to J9 (pin 4) on the Recorder Board; connect the negative lead to J9 (pin 2).
6. Adjust R31 for a reading of +150 mVdc ± 2 mVdc on the digital voltmeter.

NOTE: If you open and then close the recorder door, the reading may vary 5–10 mV, due to the loss of tension in the paper. This is acceptable and you do not need to re-adjust.

7. Open the door and verify that the reading on the digital voltmeter is greater than +4.75 Vdc.
8. Re-load the paper so that black squares show on the surface (i.e. the last several sheets of a pack).
9. Turn on the recorder.
10. The value on the digital voltmeter should go up and down as the paper surface alternates between black and white. Verify that the maximum value is greater than or equal to +2.0 Vdc.
11. Turn off the recorder.

Adjusting the Paper-Out Photosensor

1. Load paper in the recorder. Ensure that there are *no* black squares showing to indicate a paper-low condition.
2. If you haven't already, re-connect the power cord and turn on the monitor.
3. Press the **Record** button to turn on the recorder. Allow the paper to advance for a few seconds in order to tension the paper.
4. Turn off the recorder.
5. Using a digital voltmeter, connect the positive lead to J9 (pin 3) on the Recorder Board; connect the negative lead to J9 (pin 2).
6. Adjust R29 for a reading of +150 mVdc ± 2 mVdc on the digital voltmeter.

NOTE: If you open and then close the recorder door, the reading may vary 5–10 mV, due to the loss of tension in the paper. This is acceptable and you do not need to re-adjust.

7. Open the door and verify that the reading on the digital voltmeter is greater than +4.75 Vdc.
8. Turn off the recorder.

Paper-Loading Sensor

Follow the instructions for “Removing the Strip Chart Recorder” on page 10-2 before following this procedure:

Removing the Paper-Loading Photosensor

1. Disconnect the paper-loading sensor cable from J8 on the Recorder Board.
2. Turn over the recorder and place face down.
3. Cut and remove the cable tie which holds the sensor cable.
4. Remove the two screws which hold the sensor and housing to the paper tray.
5. Discard the sensor and printed circuit board.

Replacing the Paper-Loading Sensor

Use the following procedure for replacing the paper-loading photosensor:

1. Secure the sensor and printed circuit board to the paper tray and tighten both screws.
2. Connect the sensor cable to J8 on the Recorder Board.
3. Install a new cable tie to hold the cable in place.

NOTE: Ensure that there is enough slack in the cable so that when the recorder door is opened the cable does not become taut.

4. Re-install the strip chart recorder. Refer to “Installing the Strip Chart Recorder” on page 10-2. Do not replace the monitor top cover yet.
5. Adjust the paper-loading sensor as described next in this section.

Adjusting the Paper-Loading Sensor

1. Load paper in the recorder. (Refer to page 5-2 for proper loading instructions—paper should feed from the *top* of the pack.) Ensure that there are *no* black squares showing to indicate a paper-low condition. You must load at least nine sheets of paper.
2. If you haven't already, re-connect the power cord and turn on the monitor.
3. Using a digital voltmeter, connect the positive lead to J9 (pin 6) on the Recorder Board; connect the negative lead to J9 (pin 2).
4. Adjust R41 for a reading of +190 mVdc ± 5 mVdc on the digital voltmeter.
5. Although a factory-only fixture is required for this step, you may wish to try it by estimating the required distance. Load paper *backwards* (paper feeding from *bottom* of pack) with the white surface 0.380 in away from the paper tray. This creates a paper-loading error condition. Verify that the voltage at J9 (pin 6) on the Recorder Board is at least +2.70 Vdc.
6. Replace the monitor top cover and secure with all nine screws.

For your notes

Chapter 11

Peripheral Devices

The 120 Series Monitor allows connection to optional peripheral equipment.

Some of the connectors are standard on each monitor while others are part of an optional communications package. All connectors are described in this section.

NOTE: Refer to "Chapter 12, Upgrading a 120 Series Monitor", for more information.

This section discusses the following:

Standard Input/Output Connectors 11-2
Nellcor Puritan Bennett Model N-200 Maternal Pulse Oximeter 11-5
Nellcor Puritan Bennett Model N-400 Fetal Pulse Oximeter 11-6
DINAMAP Models 1846, 1846SX, and 1846SX/Oxytrack, 8100, and 8100T11-7
Quantitative Sentinel/Perinatal System 11-8
Model 115-Compatible Communications Protocols 11-9
Optional Communication Package 11-18

Standard Input/Output Connectors

Remote Marks Connector ♪

This receptacle is provided for connection to a Corometrics Model 146 Fetal Acoustic Stimulator.

Remote Marks Connector ↑

This receptacle is provided for connection to an optional Corometrics Remote Event Marker. A Corometrics Remote Event Marker is used to annotate the strip chart recorder paper with a mark.

The printed mark can be configured as ↑, commonly used to record an "event"; or it can be configured as FM↑, commonly used as an indication that the mother has perceived fetal movement. The monitor is factory set with the mark configured as an arrow. Refer to "Install Options Screen" on page 5-26 for more information on selecting the mark. Refer to the instructions accompanying the Remote Event Marker for more information about using the accessory.

ECG Out Connector

This 3-conductor stereo phone jack permits recording of FECG or MECG trends on an external recorder. FECG signals are output at +80 dB with a bandwidth of 1.0 to 100 Hz. MECG signals are output at +60 dB with a bandwidth of 0.5 to 40 Hz. The output level from this port is 10 V/mV for FECG and 1 V/mV for MECG.

CAUTION
JACK SIZES—Service personnel who are familiar with other Corometrics monitors should be aware that the stereo phone jack used on the 120 Series Monitor is a different size than that used on previous monitors.

J108 Connector (Corolan Interface)

The Corolan connector is a 25-pin connector for interfacing to a Corometrics Monarch 8000 Obstetrical Management and Archival System or a Quantitative Sentinel/Perinatal System using Corolan cabling.

For detailed information about connecting to a Monarch 8000 System, refer to the "Systems Pre-Installation Manual" (P/N 1279AA). For detailed information on connecting to a Quantitative Sentinel/Perinatal System, refer to the "Quantitative Sentinel Networking Pre-Installation Manual" (P/N 13417AA).

J109, J110, and J111 Connectors (RS-232C)

Three RS-232C serial interface receptacles allow connecting the 120 Series Monitor to the following devices:

- Nellcor Puritan Bennett (NPB) N-200 Maternal Oxygen Saturation Monitor (J109 and J111 only)
- Nellcor Puritan Bennett N-400 Fetal Oxygen Saturation Monitor*
- DINAMAP Model 1846, 1846SX, 8100, 8100T NIBP Monitors
- DINAMAP Model 1846SX/Oxytrak Critical Care Monitor
- Quantitative Sentinel/Perinatal System (any RS-232C connector)

When shipped from the GE factory, all three ports are configured as follows:

- communications mode = NELLCOR
- baud rate (bps) = 2400

At the above settings, connectors J109 and J111 are ready for connection to an NPB Model N-200. Connector J110 does not support a connection to NPB monitors; therefore, this connector will have to be configured for the device to which it is attached.

1. Select the **SERVICE** softkey from the General Setup screen.
2. The Service Lock screen appears.
3. Enter the correct access code; the Install Options screen displays.
4. Select the **COMM** softkey on the Install Options screen.
5. The Communications Setup screen appears.
6. Set the baud rate and mode for each port.

Baud Rate

This field selects the baud rate and must be compatible with the external device. Use the Trim Knob control to cycle through the available settings: 600, 1200, 2400, 4800, 9600, and 19,200 bps. (Each port is factory set to 2400 bps.)

Mode

This field selects the mode for communication and must be compatible with the external device. Use the Trim Knob control to cycle through the available settings: NELLCOR, FACTORY, CRITIKON, 1371, and 1371/NOTES. (Each port is factory set to the NELLCOR mode.)

NOTE: The FACTORY mode is reserved for factory testing only.

* *The NPB Model N-400 Fetal Pulse Oximetry Monitor is not available in all countries.*

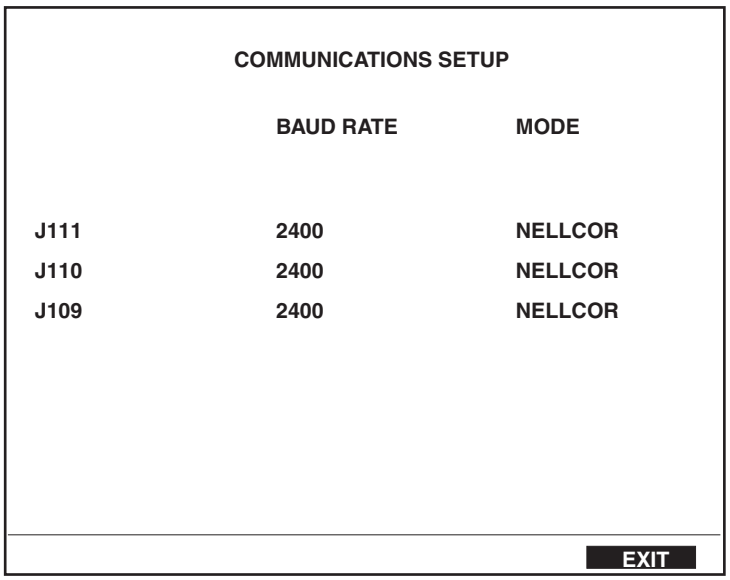


Figure 11-1. Communications Setup Screen

Nellcor Puritan Bennett Model N-200 Maternal Pulse Oximeter

Through this interface, $MSpO_2$ readings provided by an NPB Model N-200 are printed at selected intervals on the strip chart paper of the 120 Series Monitor.

When the recorder is on, each reading is printed in the annotation area between the top and bottom grids. A filled diamond marker, above the data, marks the time of the reading and identifies the data source as an external device. The following is an example annotation:

♦
$MSpO_2$ 97% P 78

When the recorder is in maternal-only mode, a time stamp and filled diamond mark precede each reading. A sample annotation looks like this:

11:13 ♦ $MSpO_2$ 97% P 78

To connect the Model N-200:

1. Using interface cable, connect one end to an available **RS-232C** port (J109 or J111 only) on the 120 Series Monitor; connect the other end to the **Serial Communications** port on the pulse oximeter.
2. Access the Communications Setup service mode screen and set the baud rate and mode for the appropriate port to 2400 and NELLCOR, respectively; then exit the service mode screens.
3. Access the General Setup screen and choose the time interval for printing the $MSpO_2$ values on the strip chart paper. Refer to “Chapter 5, Setup Procedures” in this manual for more detailed information.
4. Ensure the NPB N-200 is set to the Beat-to-Beat mode.

Nellcor Puritan Bennett Model N-400 Fetal Pulse Oximeter*

Through this interface, $FSpO_2$ readings provided by an NPB Model N-400 are printed at selected intervals on the strip chart paper of the 120 Series Monitor.

When the recorder is on, each reading is printed in the annotation area between the top and bottom grids. A filled diamond marker, above the measured values, marks the time of the reading and identifies the data source as an external device. The following is an example annotation:

♦
$FSpO_2$ 45%

In addition, the $FSpO_2$ trend can be optionally printed on the bottom grid of the strip chart paper; the trend is printed as a beaded trace (—▪—).

To connect the Model N-400:

1. Using interface cable, connect one end to an available **RS-232C** port (J109, J110, or J111) on the 120 Series Monitor; connect the other end to the **Serial Communications** port on the pulse oximeter.
2. Access the Communications Setup service mode screen and set the baud rate and mode for the appropriate port to 2400 and NELLCOR, respectively; then exit the service mode screens.
3. Access the General Setup screen, then: choose the time interval for printing the $FSpO_2$ values on the strip chart paper; and enable/disable trending of $\%FSpO_2$ on the bottom grid of the strip chart paper. Refer to "Chapter 5, Setup Procedures", in this manual for more detailed information.
4. Ensure the NPB N-400 is set to the Beat-to-Beat mode.

* *The NPB Model N-400 Fetal Pulse Oximetry Monitor is not available in all countries.*

DINAMAP Models 1846, 1846SX, and 1846SX/ Oxytrack, 8100, and 8100T

All of the above DINAMAP monitors can be interfaced to a 120 Series Monitor to provide a printout of NBP values on the strip chart paper; the Models 1846SX/ Oxytrack also provides a printout of the $MSpO_2$ values on the 120 Series Monitor strip chart as well.

1. Refer to Table 11-1 for the appropriate interface cable. Connect one end to an available **RS-232C** port (J109, J110, or J111) on the 120 Series Monitor; connect the other end to the serial communications port on the pulse oximeter. Refer to the Critikon documentation for information on the name of the connector.
2. Access the Communications Setup service mode screen and set the baud rate and mode for the appropriate port to 600 and CRITIKON, respectively; then exit the service mode screens.
3. Access the General Setup screen and choose the time interval for printing the $MSpO_2$ values on the strip chart paper. Refer to "Chapter 5, Setup Procedures", in this manual for more detailed information.
4. Be aware of the following information specific to DINAMAP monitors:
   - The clock on the Critikon Models 1846, 1846SX, and 1846SX/Oxytrack must be set to within 10 minutes of the 120 Series Monitor. If the clocks are *not* within 10 minutes of each other, the time will print with each blood pressure reading.
   - The clock on the Models 8100 and 8100T is *not* a real-time clock. Instead, the clock measures elapsed time since the monitor was turned on.
   - Due to the storage capabilities of DINAMAP monitors, it is recommended that power be cycled at the beginning of each data session. This ensures that any previously stored data is cleared.
   - When using STAT mode on a DINAMAP monitor, the 120 Series Monitor does not print the time with each reading due to overcrowding on the strip chart. Instead the time is printed once every three to five minutes.
   - The DINAMAP Model 1846SX discards NBP values after 90 minutes.
   - The DINAMAP Model 1846SX/Oxytrack does *not* discard old NBP values.
   - The DINAMAP Model 1846SX/Oxytrack will omit the pulse rate with the NBP reading if $MSpO_2$ is also in use. In other words, the pulse rate from the $MSpO_2$ reading takes priority over the pulse rate from the NBP reading.

Quantitative Sentinel/Perinatal System

Through this interface, the 120 Series Monitor outputs MHR data, FHR data, and UA data to a central information such as a Quantitative Sentinel/Perinatal System. Annotations made at the central station can be optionally printed on the strip chart paper of the 120 Series Monitor as summarized below:

- Each message is preceded by a computer icon ( ).
- Messages are restricted to a maximum length of 50 characters.
- Lower-case letters are converted to upper-case letters.
- Non-standard characters are replaced with spaces.

The 120 Series Monitor can be configured with the remote annotation capability enabled (1371/NOTES mode) or disabled (1371 mode). The following is an example of a remote message sent to a 120 Series Monitor from a central information system using this serial communications protocol.

<SPW> AVERAGE VARIABILITY

To connect a central information system:

1. Obtain an appropriate interface cable: connect one end to an available **RS-232C** connector (J109, J110, or J111) on the 120 Series Monitor; connect the other end to the wallplate wired to the central information system. For a Quantitative Sentinel/Perinatal System: the interface cable is catalog number (REF) 1376AAO; the corresponding wallplate connector is labeled **RS-232 COMMUNICATIONS**.
2. Access the Communications Setup service mode screen and set the baud rate and mode for the appropriate port to 2400 bps and either the 1371 or 1371/NOTES mode, respectively; then exit the service mode screens.

Table 11-1. External Device Summary

External Device	Parameter(S)	120 Series Baud Rate	Interconnect Cable Cat. No.		Communications Protocol
			1 ft	6 ft	
Nellcor Model N-200	$MSpO_2$	2400	1557AAO	1557BAO	NELLCOR
Nellcor Model N-400	$FSpO_2$	2400	1557AA0	1557BAO	NELLCOR
DINAMAP Model 1846	NBP	600	1562AAO	1562BAO	CRITIKON
DINAMAP Model 1846SX					
DINAMAP Model 1846SX/Oxytrack	NBP, $MSpO_2$				
Quantitative Sentinel System	Annotations (optional)	1200	1558AAO	1558BAO	1371 or 1371/NOTES

Model 115-Compatible Communications Protocols

Two options provide backward-compatibility so that the 120 Series Monitor can operate in a Model 115-compatible communication mode.

- 115 Update Mode: The 115 Update mode outputs all available information and ignores requests from a host computer system.
- 115 Transmit/Receive: The 115 Transmit/Receive mode only outputs data requested from a host computer system.

When the Model 115 Fetal Monitor was released, many customers developed their own interfaces for communicating with the monitor. Setting the 120 Series Monitor to one of these communication modes allows these users to use their existing interfaces with the 120 Series Monitor as well.

The 120 Series Monitor emulates the Corometrics Model 830 Converter's implementation of the 115 Communication Protocols. This protocol is named after the Corometrics Model 115 Fetal Monitor in which it originated.

NOTE: The baud rate must match the external computer; however, the recommended baud rate is 9600. Lower baud rates may result in some data loss.

IMPORTANT
FETAL VS. MATERNAL—This is a "fetal" protocol, not a "maternal/fetal" protocol. This protocol will output HR1, HR2, UA, modes, and message annotations (including maternal vital signs). This protocol will not send three heart rates, waveforms, or HRC.

115 Update Mode

All information is transmitted from the 120 Series Monitor as soon as the information becomes available.

IMPORTANT
DATA REQUESTS—When set to the 115 Update Mode, the 120 Series Monitor will ***not*** respond to any requests for information sent from an external (host) computer.

Heart rate data is transmitted on a quarter second basis. Uterine activity is transmitted eight times per second. Modes are transmitted once per minute, and whenever a mode change occurs. Model 2115/2116 messages are sent as they are received. Event marks are transmitted each time the **Mark** pushbutton is pressed. Fetal movement data is transmitted four times per second. Recorder status (PAPER OUT) information is transmitted once per second, when active, until the condition is resolved.

NOTE: Refer to "Requested Data Format" later in this document for information about the response data format. The format is the same for both the 115 Update mode and the 115 Transmit/Receive mode.

115 Transmit/Receive Mode

Once a valid request for data is received, the 120 Series Monitor will send only the information that is requested. The selection of this information is done by sending a request stream to the 120 Series Monitor. After processing the request, the 120 Series Monitor will then send only the *selected* parameters to the external computer. The information selected by the external computer will be transmitted following the same criteria described for the 115 Update Mode. The requested parameters may be changed at any time by the host computer by sending a new request sequence.

NOTE: Refer to "Requested Data Format" later in this document for information about the response data format. The format is the same for both the 115 Update mode and the 115 Transmit/Receive mode.

Requested Data Format

The format of the data *requested* by the external computer from the monitor is shown in Figure 11-2.

NOTE: This applies to 115 Transmit/Receive mode only.

The definitions of the bytes are as follows:

Monitor Type

This field contains a 1-byte ASCII value indicating the type of monitor from which information is being requested. The 120 Series Monitor is set to a fixed value of 9 (39H).

Data Field

This field of 1 to 8 bytes indicates which parameters the external computer wishes to receive. The values for the bytes are given in Table 11-2.

End of Text

This 1-byte field contains the value 03H. If this byte is sent immediately following the Monitor ID, then the 120 Series Monitor will cancel transmission of all data.

Transmitted Data Format

The format of the information *transmitted* from the 120 Series Monitor to the external computer is shown in Figure 11-3.

NOTE: This applies to both 115 Update mode and 115 Transmit/Receive mode.

The definitions of the bytes are as follows:

Monitor Type

This field contains a 1-byte ASCII value indicating the type of monitor sending the information. The 120 Series Monitor is set to a fixed value of 9 (39H).

Response Type

This 1-byte value indicates the type of information being sent from the 120 Series Monitor as shown in Table 11-1.

Monitor ID

This 1-byte ASCII value indicates the ID number of the monitor information. The 120 Series Monitor sets this byte to a fixed value of 0 (30H).

Data Field

This field of n-bytes contains the actual data sent from the monitor to the external computer. The contents of this field for each response is given below:

Event Mark

This data field is empty whenever the monitor's **Mark** pushbutton is pressed.

Heart Rate

This data field contains two or three ASCII characters representing the value of the heart rate. A value of 00 (30H, 30H) indicates a penlift condition. Heart rate data (including penlift data) is transmitted four times per second.

Uterine Activity

This data field contains two or three ASCII characters representing the value of uterine activity. A value of 128 (31H, 32H, 38H) indicates a penlift condition. Uterine activity data (including penlift data) is transmitted eight times per second.

Modes

This data field contains two ASCII characters indicating the mode. The first character is the combined mode of both heart rates according to Table 11-2. The second character is the mode for uterine activity as listed in Table 11-3. Mode data is transmitted at startup, with each mode change, with each request, and once every minute.

Annotations

This field of n-bytes contains actual ASCII data making up messages sent to the 120 Series Monitor. This information can be: messages sent from a Model 2115/2116B Data Entry System; or patient parameter information (SpO_2 and/or NBP) from the monitor's internal modules or external devices connected to the monitor.

Fetal Movement

This field contains one ASCII character representing the current status of the FM signal: low or high. If the data byte is a 0 (30H), then the signal is low indicating no movement is detected; if the data byte is 1 (31H), then the signal is high indicating fetal movement is detected. If the fetal movement feature is not in the monitor, the data byte is 2 (32H). If the fetal movement feature is present but not *enabled*, the data byte is 4 (34H). This data is transmitted four times per second. (Fetal movement detection circuitry is an option which can be purchased for the 120 Series Monitor. Refer to the *120 Series Monitor Service Manual* for more information.)

Recorder Status

This field contains one ASCII character representing the current status of the PAPER OUT* signal: low or high. If the data byte is a 0 (30H), then the signal is low indicating paper is loaded and the recorder door is closed; if the data byte is 1 (31H), then the signal is high indicating a paper out condition. This data is transmitted once per second, when active.

End of Text

This 1-byte field contains the value 03H. If this byte is sent immediately following the Monitor ID, then the 120 Series Monitor will cancel transmission of all data.

Limitations

The only restriction on the information transmitted during either 115 communication mode occurs when the baud rate is set below 4800 baud. Under this condition, data loss may occur.

NOTE: The recommended baud rate is 9600.

Error Conditions

Transmission Errors

Transmission errors may be detected by the external computer as parity errors, framing errors (no valid stop bit), or invalid characters. There is no facility in the 120 Series Monitor to re-transmit any information found to contain an error. It is therefore up to the user to decide what action to take as a result of an error.

Request Errors

These errors apply to the 115 Transmit/Receive Mode only.

Request errors are detected by the monitor as parity errors, framing errors, and invalid Monitor ID. If the monitor fails to respond properly to a request, it is suggested that the external computer re-transmit a request sequence.

Figure 11-2. Data Request Format—115 Transmit/Receive Mode Only

Figure 11-3. Transmitted Data Format

Table 11-2. Response Type and Data Field Type

Response Type	ASCII Character	Hexadecimal Value
Heart Rate 1	`	60
Uterine Activity	a	61
Modes	b	62
Vital Signs Annotations and Model 2115/2116 Messages	c	63
Event Mark	d	64
Heart Rate 2	e	65
Fetal Movement	f	66
Paper Out	g	67

Table 11-3. Heart Rate Modes			
Hr1 Mode	Hr2 Mode	Ascii Character	Hexadecimal Value
INOP	INOP[a]	0	30
FECG	INOP[a]	1	31
US	INOP[a]	2	32
US	MECG	5	35
US	FECG	9	39
US	US2	;	3B
FECG	US	<	3C
INOP	MECG	=	3D
INOP	US2	>	3E

[a] *If HR2 mode is INOP and HR3 mode is MECG, then HR3 mode and data are sent as HR2 mode and data.*

Table 11-1. Uterine Activity Modes		
UA Mode	ASCII Character	Hexadecimal Value
INOP	0	30
TOCO	1	31
IUP	2	32

Cabling Information

Monitor RS-232 Connector

The 120 Series Monitor's RS-232C Ports each use a 6-pin RJ-11C connector, shown in Figure 11-4.

The following control signals are supported:

Request to Send (RTS)

This output line is asserted (+12 V) whenever the 120 Series Monitor is on and operating; it can be used to determine whether the monitor is powered on.

NOTE: This signal is supported by connectors J109 and J111 only. This signal is not supported by connector J110.

Transmit Data (TXD)

This output line provides the serial data sent to the external computer from the 120 Series Monitor.

Clear to Send (CTS)

This input line must be asserted in order to enable the transmission of data from the 120 Series Monitor. Under conditions where no modem is used, the line can be tied to the RTS line of the monitor. If a modem is used, this line should be tied to the CTS line of the modem.

NOTE: This signal is supported by connectors J109 and J111 only. This signal is not supported by connector J110.

Receive Data (RXD)

This input line provides the serial data sent from the external computer to the 120 Series Monitor.

Standard RS-232C Rules

The following rules must be observed:

- When a direct connection is made between a 120 Series Monitor and another Data Terminal Equipment (DTE), a standard null-modem cable must be used.
- When an indirect connection is made, using a modem, a 120 Series Monitor requires a normal-modem cable.

Cable Distance

The RS-232C Interface supplied with the 120 Series Monitor is capable of operating over varying distances depending upon the data rate used and whether the cabling is shielded or unshielded. Refer to the manufacturer's specifications.

Data Terminal Equipment Cabling

When the 120 Series Monitor is directly connected to another Data Terminal Equipment (DTE) device, a standard null-modem cable is required as shown in Figure 11-5.

Data Communications Equipment Cabling

When the 120 Series Monitor is connected to a Data Communications Equipment (DCE) device (a modem), a standard normal-modem cable is required as shown in Figure 11-6.

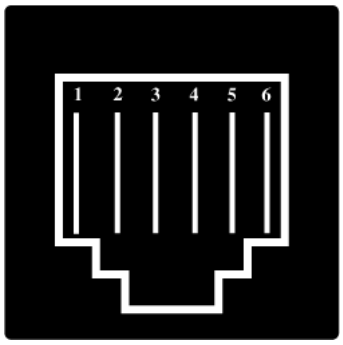


Figure 11-4. RJ-11C Connector
(while facing the monitor's rear panel)

Table 11-2. J109, J110, and J111 RS-232 Port Connector Pinout	
J109, J110, or J111 Pin #	Signal Description
1	RTS[a]
2	RXD
3	GND
4	GND
5	TXD
6	CTS[a]

[a] *This signal is supported by connectors J109 and J111 only. This signal is not supported by connector J110.*

120 SERIES MONITOR SIDE		DATA TERMINAL EQUIPMENT (DTE) SIDE			
6-PIN	SIGNAL NAME	SIGNAL NAME	25-PIN	9 PIN	6 PIN
5	TXD	TXD	2	3	2
2	RXD	RXD	3	2	5
1	RTS	RTS	4	7	1
6	CTS	CTS	5	8	6
3	GND	GND	7	5	3
4	GND				

Figure 11-5. Standard Null-Modem Cable

120 SERIES MONITOR SIDE		DATA TERMINAL EQUIPMENT (DTE) SIDE			
6-PIN	SIGNAL NAME	SIGNAL NAME	25-PIN	9 PIN	6 PIN
5	TXD	TXD	2	3	5
2	RXD	RXD	3	2	2
1	RTS*	RTS	4	7	1
6	CTS*	CTS	5	8	6
3	GND	GND	7	5	3
4	GND				

** This signal is supported by connectors J109 and J111 only. This signal is not supported by connector J110.*

Figure 11-6. Standard Normal-Modem Cable

Optional Communication Package

The communication option is an additional circuit board that can be installed in the 120 Series Monitor. Contact your GE Service Representative for upgrade information.

J101 Connector (Model 340 Telemetry System Interface)

This connector is for future interfacing to the receiver of a Corometrics Model 340 Telemetry System.

A telemetry indicator is displayed (see Figure 5) in the top left corner of the screen if:

- you connect a telemetry receiver to the 120 Series Monitor; and
- the receiver detects an active FECG, MECG, US, TOCO, or IUP mode from the associated transmitter.

NOTE: The monitor, receiver, and transmitter must all be turned on.

NOTE: When any telemetry mode is detected (US, FECG, MECG, TOCO, or IUP), all equivalent front panel modes (US, US2, FECG, MECG, TOCO, or IUP) are ignored. You ***cannot*** "mix and match" telemetry and monitor modes.

The telemetry *connected* annotation is printed on the bottom line of the top grid of the strip chart paper:

- upon commencement of telemetry monitoring; and
- every 30 minutes along with the modes.

The telemetry *disconnected* annotation is printed on the strip chart paper if:

- you unplug the telemetry receiver from the 120 Series Monitor;
- you turn off the receiver;
- you turn off the transmitter; or
- the receiver does not detect any active mode information from the transmitter.

J102 Connector (Spectra 400 Analog Interface)

This connector is designed for interfacing to a Corometrics Spectra 400 Central Surveillance and Alert System or other compatible analog central information system. For detailed information about connecting to a Spectra 400 System, refer to the "Systems Pre-Installation Manual" *(P/N 1279AA)*.

J103 Connector (Model 2116B Data Entry Interface)

This connector is specifically designed for connecting to an optional Corometrics Model 2116B Data-Entry/Clinical-Notes Keyboard. For detailed information about connecting the Model 2116B to the monitor, refer to the "Model 2116B Product Manual" *(P/N 1252BA)*.

Chapter 12

Upgrading a 120 Series Monitor

This chapter provides a table of available upgrade kits as well as instructions for installing each kit. Contact your GE Service Representative for information about purchasing a kit.

This section discusses the following:

General Information 12-2
Communications Option Upgrade Kit 12-3
Nellcor MSpO2 and NBP Option Upgrade Kit 12-7
MECG Option Upgrade Kit 12-28
Software Version 3.5 12-34
Display Upgrade 12-40
Fetal Movement Detection 12-40

General Information

Handling Precautions

The following guidelines should be followed when handling *circuit boards or assemblies containing circuit boards*. Following these procedures helps resist damage that can be caused by static electricity.

- Discharge any static charge you may have built up before handling parts.
- Wear a grounded, anti-static wristband at all times.
- Use a static-free work surface.
- Store items in anti-static bags or boxes.
- Do not remove items from anti-static containers until needed.

Equipment Required

You will need the following equipment:

- Phillips Screwdriver
- Universal Plastic Leaded Chip Carrier (PLCC) Extractor Hand Tool (for software version 3.01 upgrade only)
- Anti-Static Wristband
- Static-Free Work Surface

Testing

CAUTIONS

Following completion of any upgrade procedure:

LEAKAGE TEST—Perform a leakage and dielectric test on the 120 Series Monitor per applicable standards.

FUNCTIONAL TEST—Perform a functional test of the overall monitor following the instructions provided in "Chapter 6, Functional Checkout Procedure".

For a listing of available upgrade kits, refer to "Chapter 14, Replacement Parts".

Communications Option Upgrade Kit

The Communications Option Upgrade Kit adds the following communications ports to the monitor:

- J101: interface to Corometrics 340 Series Telemetry System
- J102 (analog interface): interface to central station system such as Corometrics Spectra 400 Surveillance and Alert System
- J103: optional data entry system such as Corometrics Model 2116
- J104: interface to standard Nurse Call System
- J108: interface to Corometrics Monarch 8000 Obstetrical Management and Archival System

Installation instructions are included in the kit; they are repeated here for informational purposes.

Unpacking

Unpack the upgrade kit and ensure it contains all items on the packing list. If something is missing, contact your Service Representative immediately.

Installation

1. Turn off the 120 Series Monitor and disconnect the power cord from the monitor.
2. Remove the nine screws which secure the monitor top cover. Four screws are located on the bottom of the monitor and five screws are located in the back.
3. Remove the cover by sliding it toward the rear of the monitor.
4. Remove the four screws which attach the blank cover plate to the rear panel.
5. Discard the cover plate and corresponding four screws.
6. Remove the Communications Board (No. 15297) from its anti-static container.
7. Insert the Communications Board into the last slot (J5) on the Main Motherboard; the connector assembly must face the rear of the monitor. (Refer to Figure 12-1 and Figure 12-2.)
8. Attach the Communications Board to the rear panel using the four screws provided in the kit.
9. Locate switch pack SW1 on the Main Motherboard and set switch 2 to the ON position for use with a Corometrics Central System or OFF for use with a Hewlett-Packard Central System. (See Figure 12-2.)
10. Replace the top cover and secure all nine screws.
11. Apply the rear panel overlay label to the connector assembly on the Communications Board. Use the version with the appropriate language for the monitor. (Refer to Figure 12-3.)

12. Connect applicable device(s) to the appropriate connectors on the monitor: J101, J102, J103, and J104.
13. Although J104 is physically present on the Communications Board, it is only supported in software as part of the Spectra Alerts option. The board is shipped with a plug inserted in J104.
14. Re-connect the monitor power cord and turn on the monitor.
15. Test all functions of the devices connected to the monitor.
16. Fill out the Update Installation Verification Form included in the kit. Be sure to include the monitor's serial number and catalog number on the form. Follow the instructions on the form to fax ***or*** mail the form to GE Medical Systems, Inc.

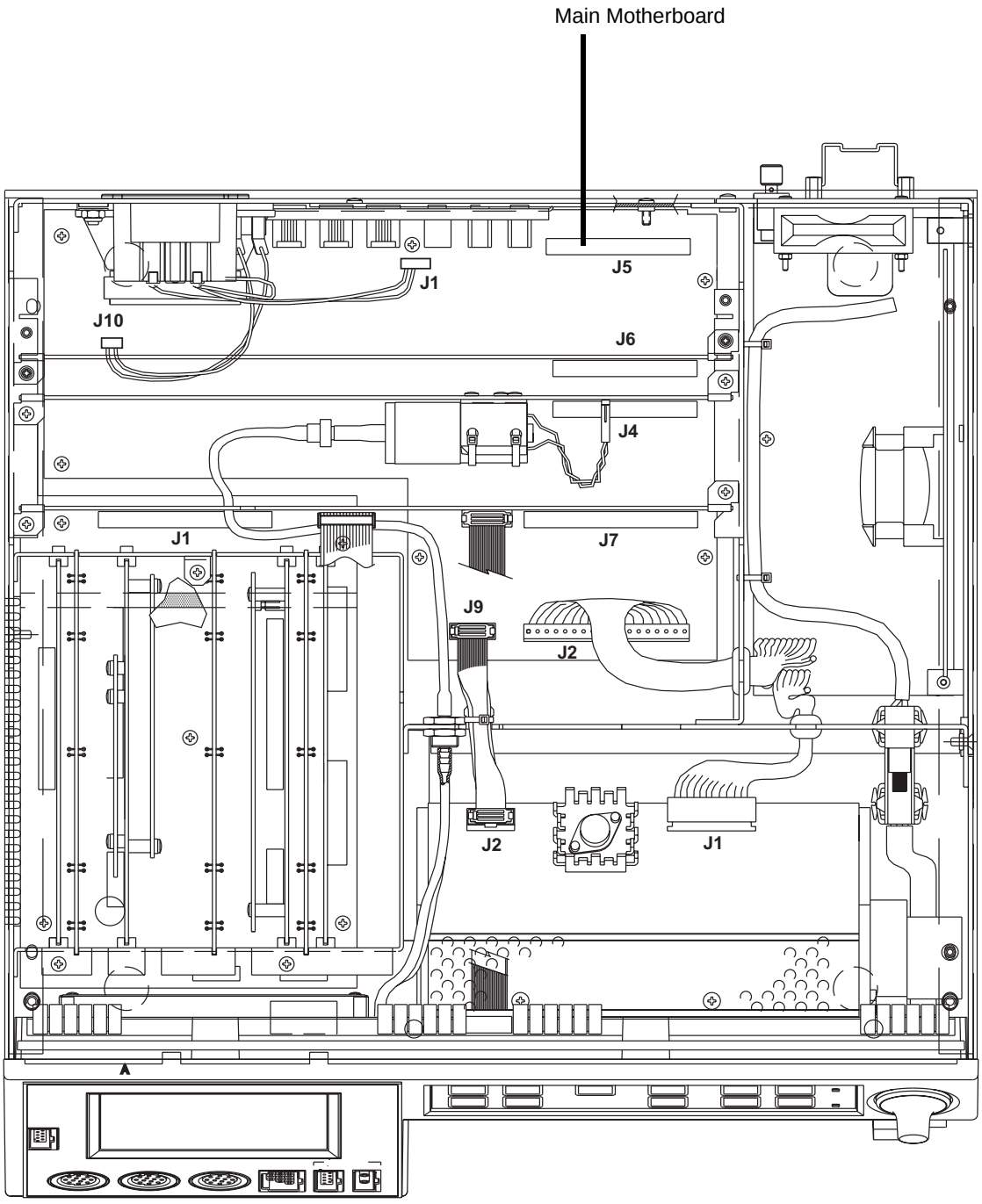


Figure 12-1. Top View

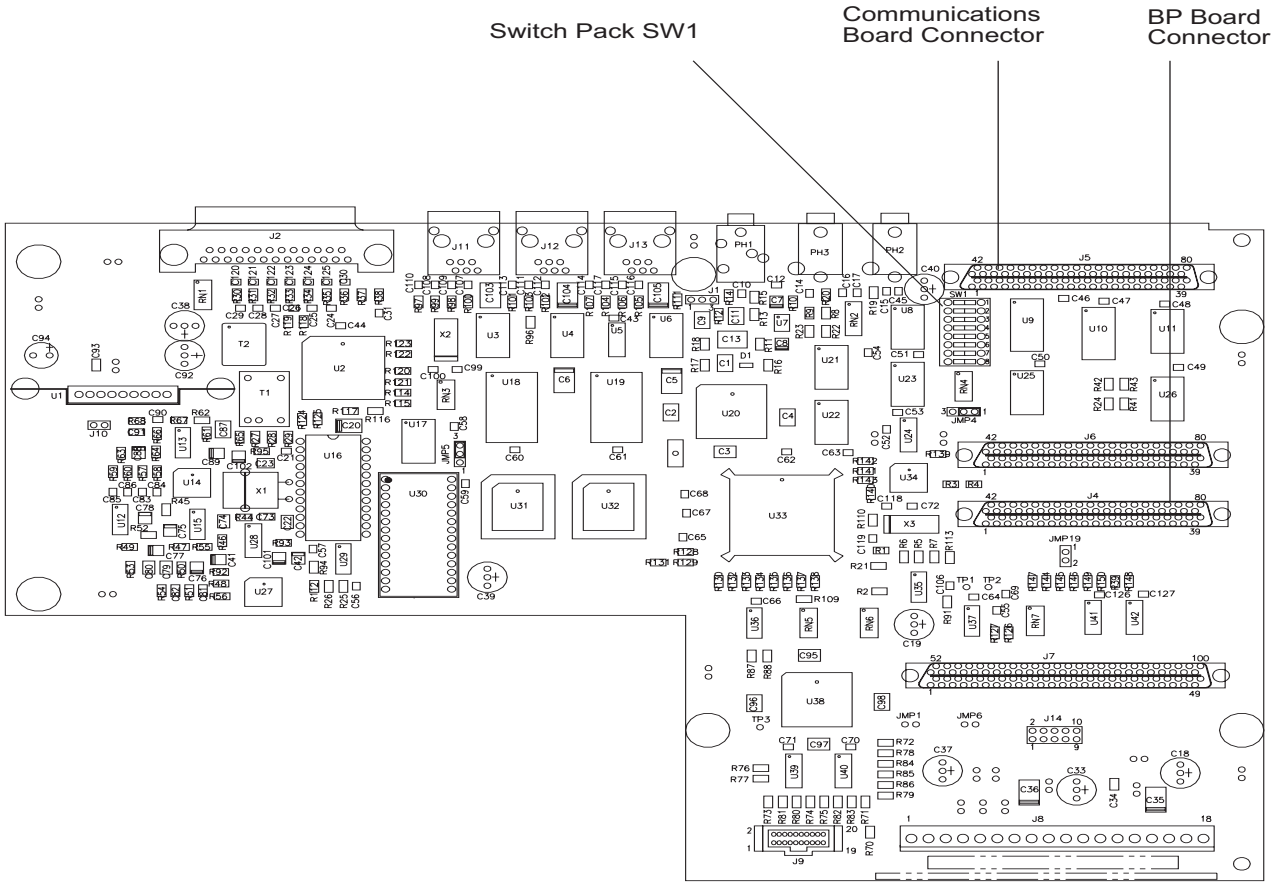


Figure 12-2. Main Motherboard

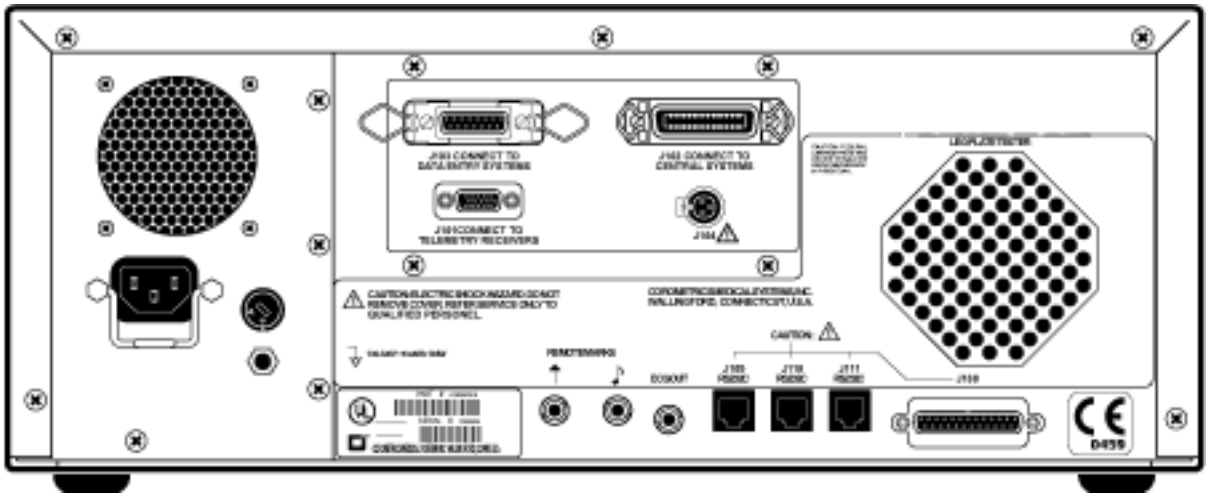


Figure 12-3. Rear Panel

Nellcor MSpO2 and NBP Option Upgrade Kit

The Nellcor MSpO2 and NBP Option Upgrade Kit adds Nellcor maternal pulse oximetry and maternal blood pressure monitoring functionality to Model 126/126F Monitors. Four Nellcor kits are available. Refer to "Chapter 14, Replacement Parts" for further information.

Monitors with a 3-inch x 3.75-inch Display

Installation instructions are provided with the kit; they are repeated here for information purposes.

Unpacking

Unpack the kit and ensure it contains all items on the packing list. If something is missing, contact your GE Medical Systems Service Representative immediately.

Installation

NOTE: Unless otherwise instructed, retain all hardware for re-assembly.

1. Turn off the 120 Series Monitor and disconnect the power cord from the monitor.
2. Use a flathead screwdriver to pry off the blank plugs inserted in the **Maternal SpO2** and **BP** connectors on the front panel of the monitor. Discard these plugs.
3. Remove the nine screws which secure the monitor top cover. Four screws are located on the bottom of the monitor and five screws are located in the back.
4. Remove the cover by sliding it toward the rear of the monitor.
5. Disconnect the display interconnect cable from the DSP Board at J5. (Refer to Figure 12-4.)
6. Disconnect the ribbon cable from the Recorder Board at J2. Leave the other end connected to the Main Motherboard. (Refer to Figure 12-5.)
7. Disconnect the Power Supply cable harness from the Recorder Board at J1. (Refer to Figure 12-5.)
8. Disconnect the ribbon cable from the membrane switch panel. Leave the other end connected to the DSP Board.
9. Remove the four screws which fasten the front bezel to the monitor—two on each side.
10. Gently tilt the bezel forward until it lays flat. Be careful not to disconnect the front end harness cable ferrite beads from their clips. The number of beads varies depending on which options are installed in your monitor. (Refer to Figure 12-6.)
11. Disconnect the Trim Knob cable assembly from the membrane switch panel.
12. Remove the five screws which secure the membrane switch panel bracket to the front bezel. Discard the screws.
13. Remove the bracket with attached membrane switch panel and discard.

14. Peel off the adhesive backing from the new membrane switch panel supplied with the kit.
15. Insert the new membrane switch panel into place in the front bezel—adhesive side up. Ensure the switch panel is oriented correctly.
16. Carefully line up the new bracket (provided in the kit) with the screw holes and press into place over the membrane switch panel.
17. Secure the bracket to the front bezel using the five #4-40 x 3/16 screws provided in the kit.
18. Re-connect the Trim Knob cable assembly to the six pin connector on the membrane switch panel.
19. Ensure the front end harness cable ferrite beads are inserted in the corresponding clips. (Refer to Figure 12-6.)
20. Replace the front bezel and secure with all four screws.
21. Re-connect the ribbon cable from the DSP Board to the membrane switch panel.
22. Re-connect the Power Supply harness cable to J1 on the Recorder Board.
23. Re-connect the ribbon cable from the Main Motherboard to J2 on the Recorder Board.
24. Re-connect the display interconnect cable to the DSP Board at J5.
25. Remove the adhesive backing from the overlay label and carefully align over the front panel membrane switches. (Refer to Figure 12-7.)
26. Remove the Blood Pressure Board from its anti-static container.
27. Insert the Blood Pressure Board into the slot labeled J4 on the Main Motherboard. (Refer to Figure 12-8.)
28. Secure the board to the chassis using the two #6-32 x 3/8 screws provided in the kit.
29. Route the blood pressure tubing through the notch at the top of the DSP Board. (See Figure 12-8.)
30. Attach the tubes to the nipples located at the divider to the recorder cavity. (See Figure 12-8.)
31. Remove the hold-down cover for the front end boards. Three screws secure the top; one screw is located on the side panel.
32. *If FSpO2 is already installed* in your monitor, disconnect the FSpO2 harness cable from the FSpO2 Board at J1. Remove the Oximeter Carrier Board from the Front End Motherboard; this board occupies the second slot from the left while facing the front of the monitor.

    If FSpO2 is not installed in your monitor, remove the Oximeter Carrier Board from its anti-static container.

NOTE: The Oximeter Carrier Board is designed so that the MSpO2 Board mounts on one side, while the FSpO2 Board (if installed) mounts on the other side. The MSpO2 Board mounts on the *component* side—with the two ribbon cables.

33. Place the Oximeter Carrier Board on a static-free work surface so that J1 is on the bottom left and J4 is at the bottom right.
34. Remove the MSpO2 Board from its anti-static container.
35. Align the MSpO2 Board over the Oximeter Carrier Board screw holes.
36. Use the washers and #4-40 x 1/4 screws provided in the kit to secure the MSpO2 Board to the Oximeter Carrier Board. Use the flat washer for the top left screw; use the shoulder washers for the remaining three screws. (Refer to Figure 12-9.)
37. Connect the ribbon cable from J2 on the Oximeter Carrier Board to JP5 on the MSpO2 Board.
38. Connect the ribbon cable from J5 on the Oximeter Carrier Board to JP1 on the MSpO2 Board.
39. Insert the Oximeter Carrier Board into the slots labeled J9 and J13 on the Front End Motherboard. (See Figure 12-10.)
40. Connect the front panel MSpO2 harness cable to J6 on the Oximeter Carrier Board.

    NOTE: The MSpO2 harness cable is already connected to the front panel in all 120 Series Monitors.

41. *If FSpO2 is installed in your monitor*, re-connect the front panel FSpO2 harness cable to J1 on the FSpO2 Board.
42. Replace the hold-down cover for the front end boards and secure with all four screws.
43. Locate switch pack SW1 on the Main Motherboard and set switches 6 and 7 to the OFF position. (See Figure 12-8.) This enables the MSpO2 and Blood Pressure Boards to communicate with Main Motherboard.
44. Ensure that the blood pressure tubing remains routed through the notch at the top of the DSP Board.
45. Replace the top cover and secure all nine screws.
46. Disconnect all cables from the monitor's front panel connectors.
47. Re-connect the monitor power cord.
48. *If FSpO2 is not installed* in the monitor, turn on the monitor and verify that the **NBP** and **MSpO2** parameter titles display on the screen. An "empty" pulse amplitude indicator should also appear in the MSpO2 area. (Refer to Figure 12-11.)

    If FSpO2 is installed in the monitor, connect both the MSpO2 and FSpO2 sensors. Turn on the monitor and verify that the **NBP**, **MSpO2**, and **FSpO2** parameter titles display on the screen. An "empty" pulse amplitude indicator should appear in both SpO2 areas. (Refer to Figure 12-11.)

49. Fill out the Update Installation Verification Form included in the kit. Be sure to include the monitor's serial number and catalog number on the form. Follow the instructions to fax the form to GE.

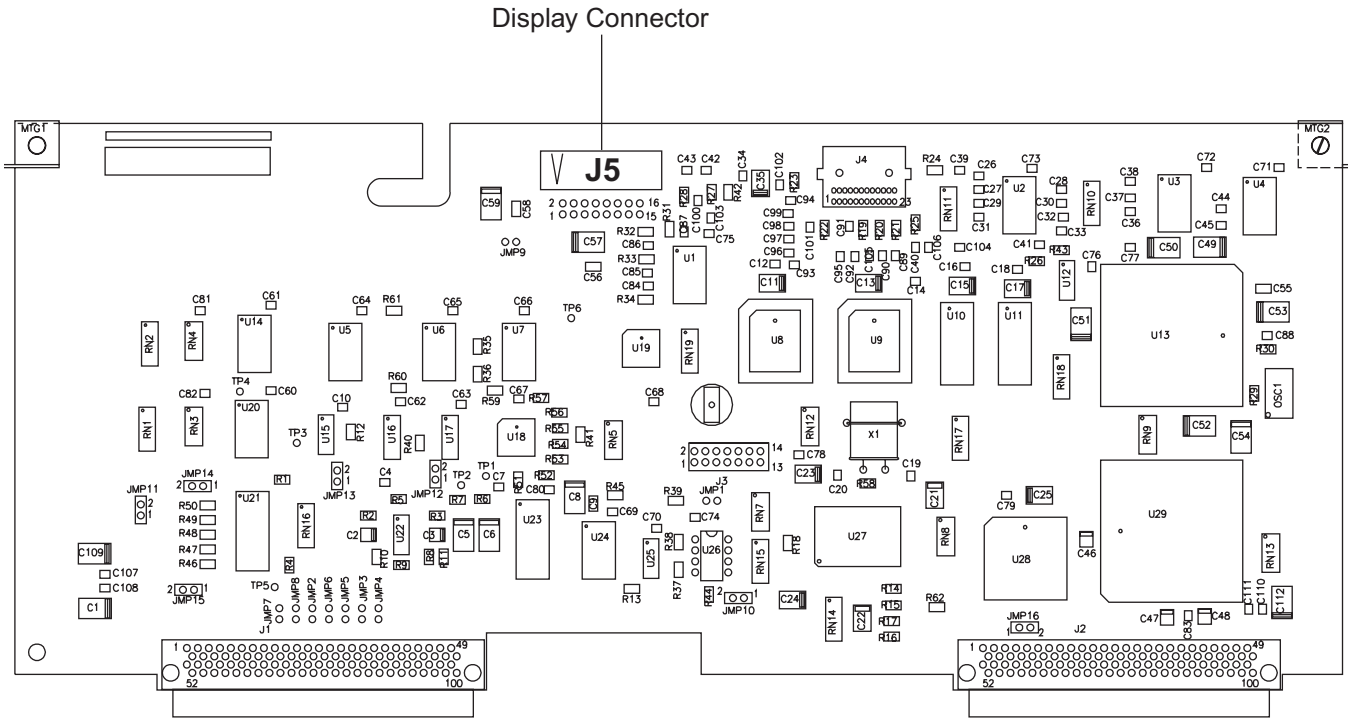


Figure 12-4. DSP Board

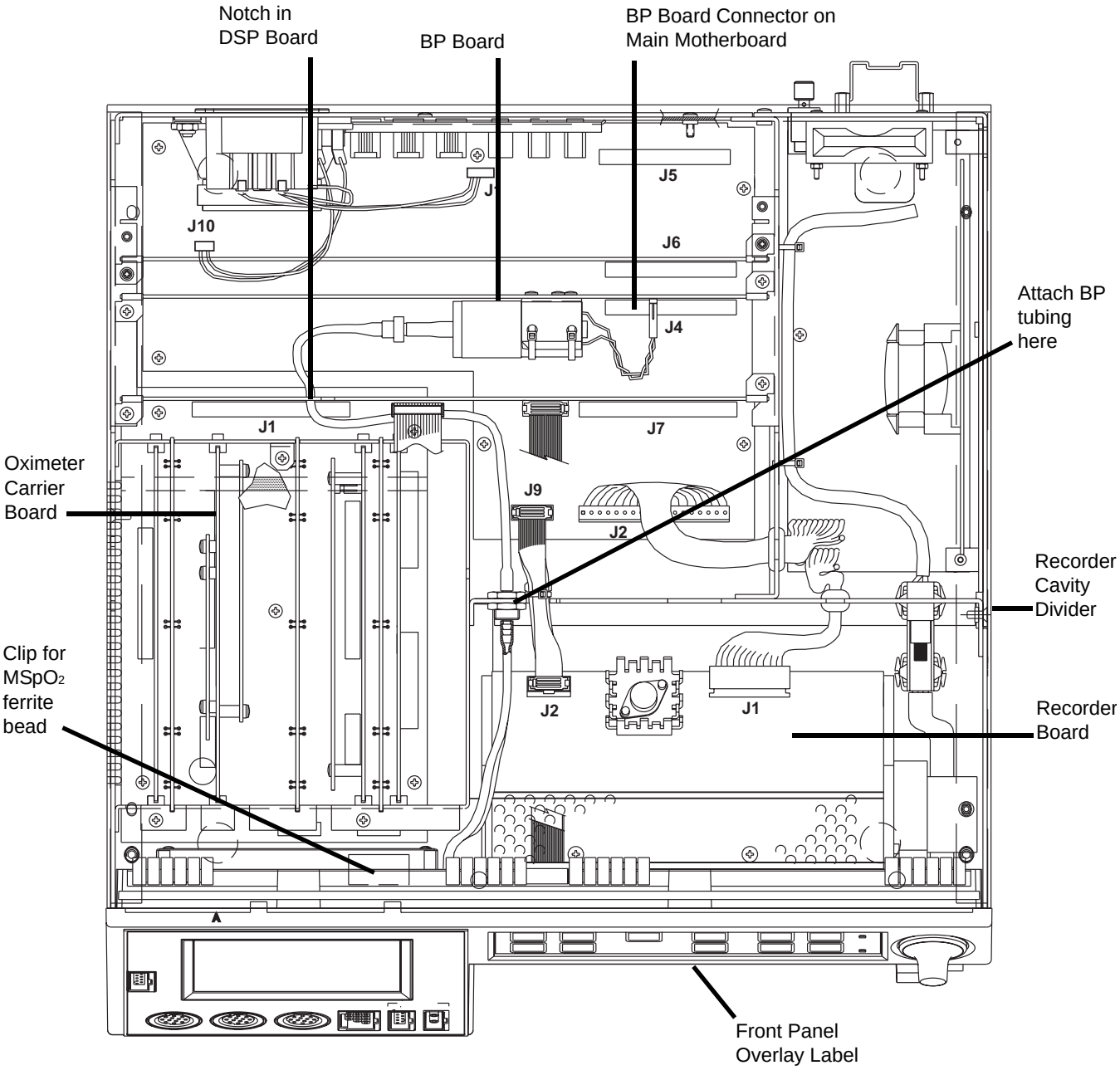


Figure 12-5. Top View

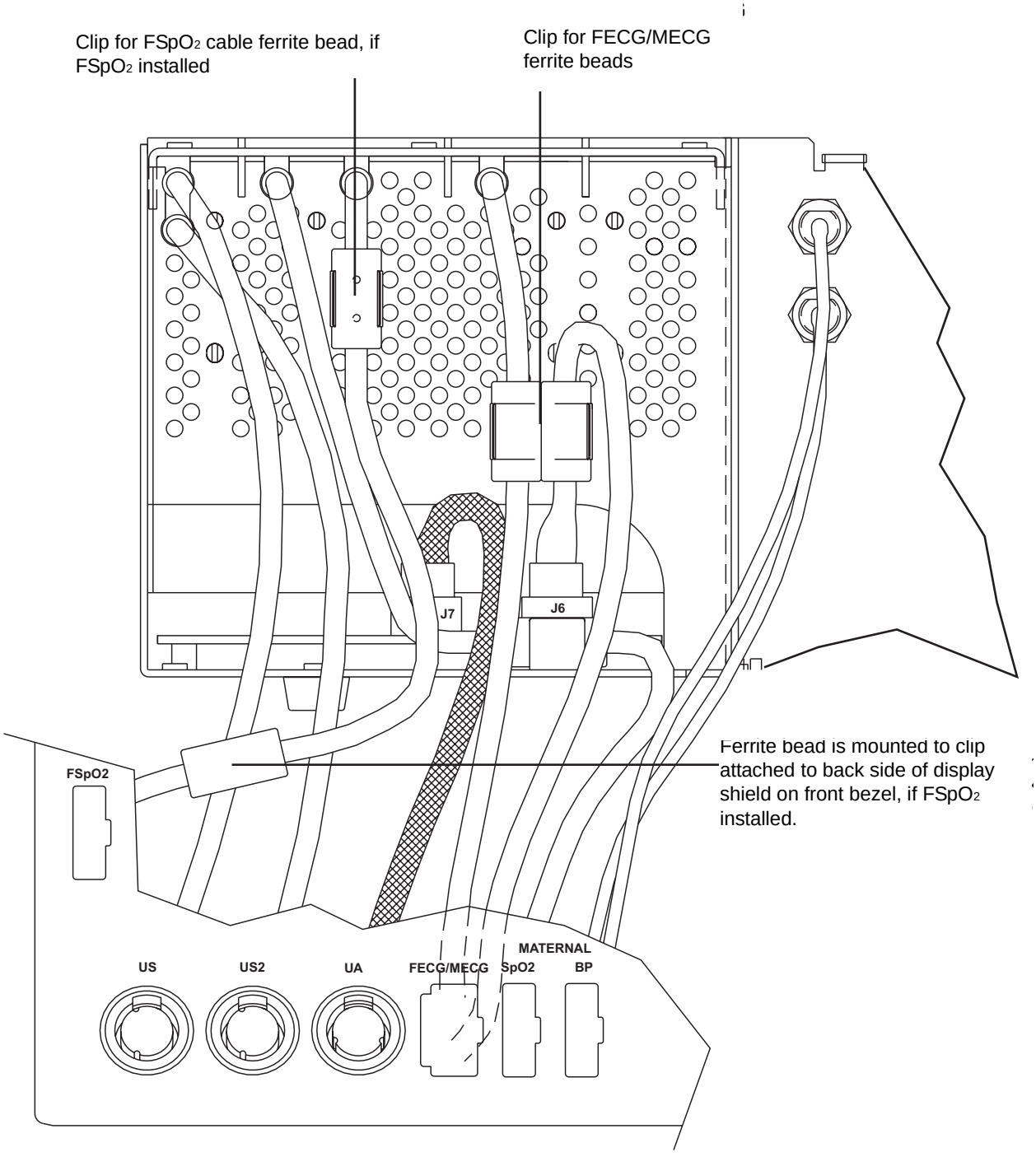


Figure 12-6. Partial Inside Front Panel with Bezel Removed

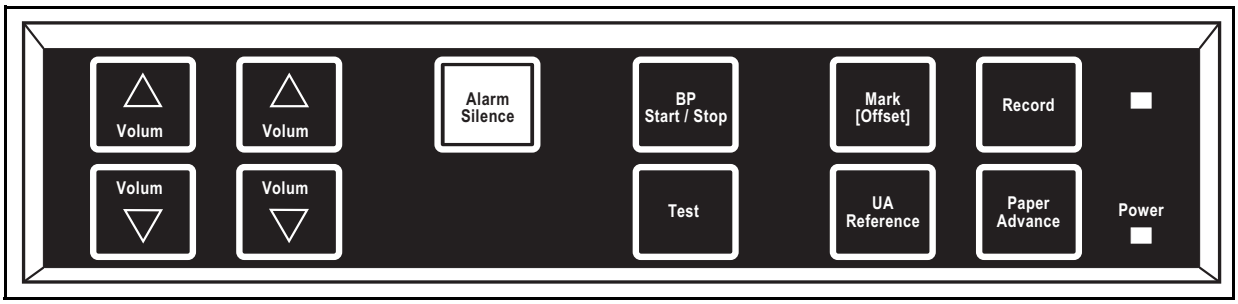


Figure 12-7. Front Panel Overlay Label

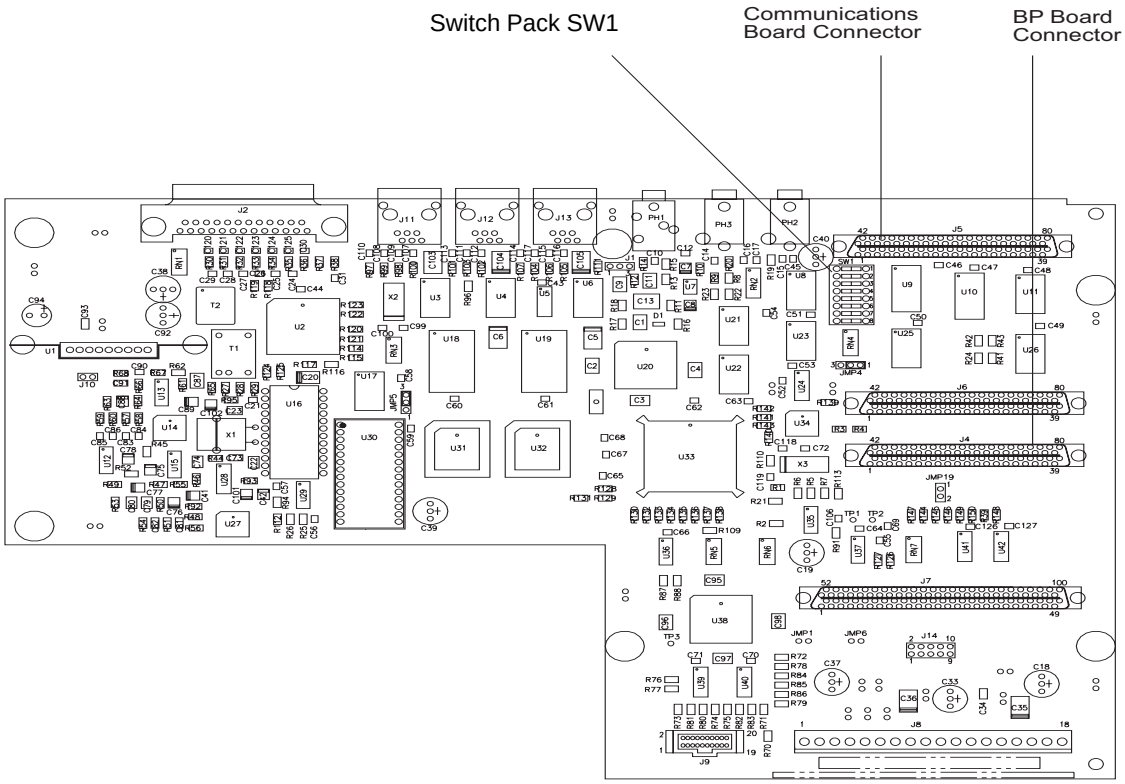


Figure 12-8. Main Motherboard

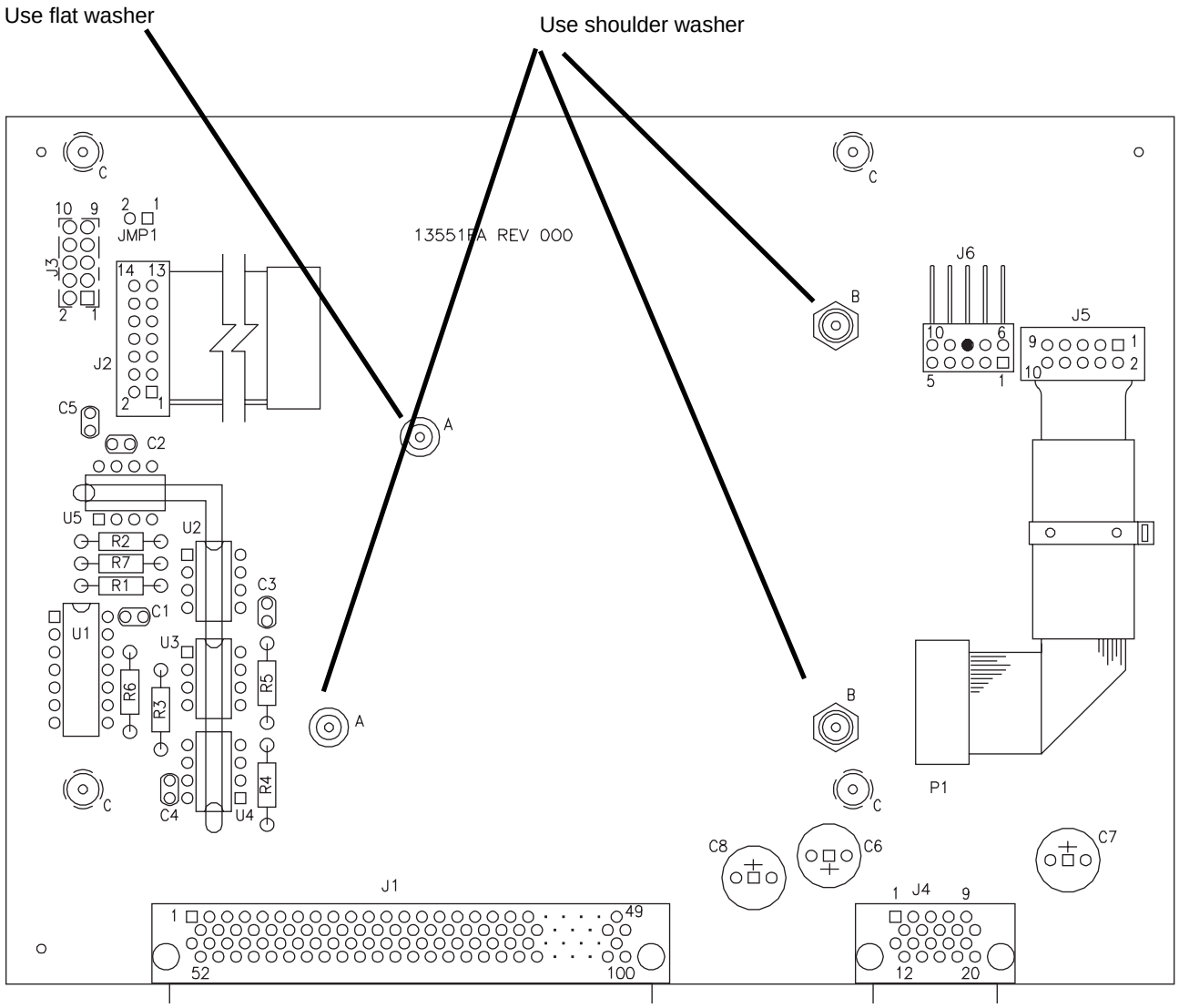


Figure 12-9. Oximeter Carrier Board

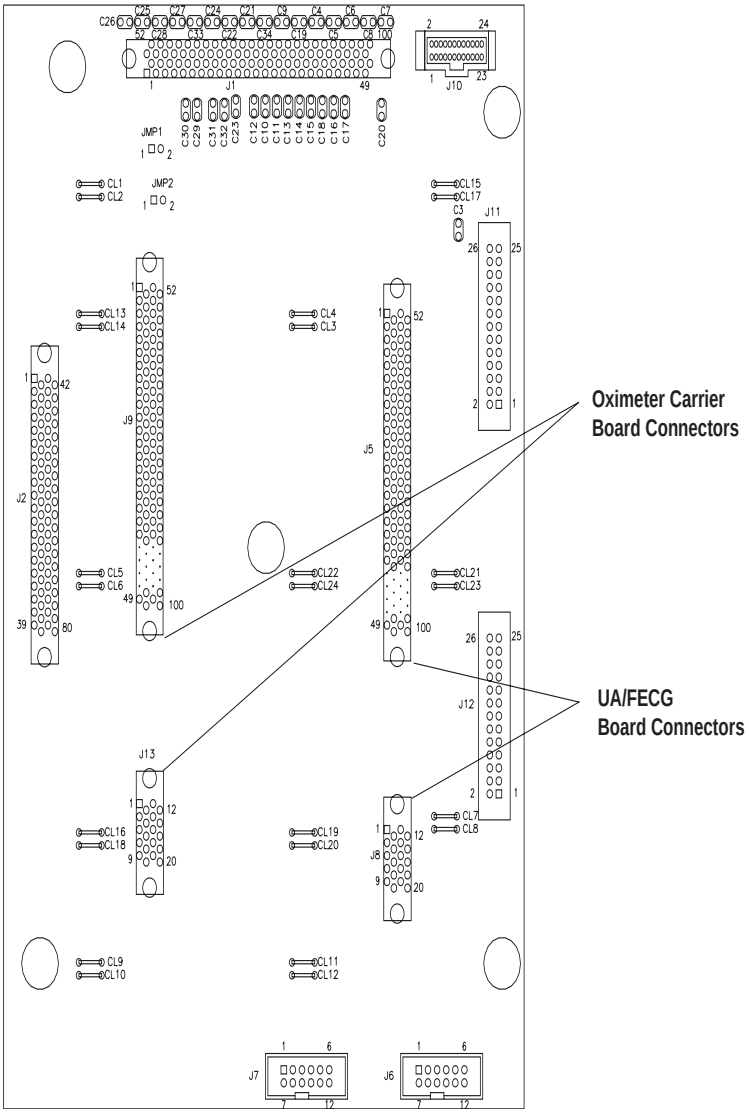


Figure 12-10. Front End Motherboard

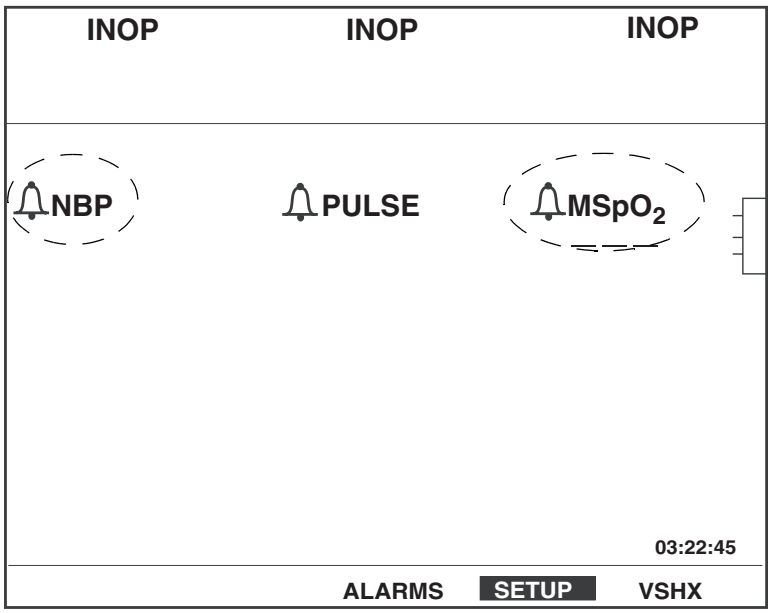


Figure 12-11. NBP and $MSpO_2$ Areas on Display

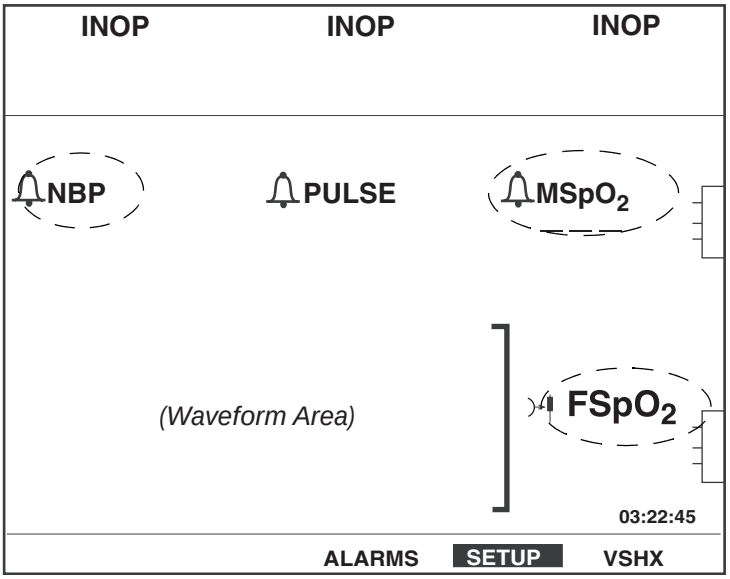


Figure 12-12. NSP, $MSpO_2$, and $FSpO_2$ Areas on Display

Monitors with a 3.5-inch x 4.5-inch Display

Installation instructions are provided with the kit; they are repeated here for information purposes.

Unpacking

Unpack the kit and ensure it contains all items on the packing list. If something is missing, contact your GE Medical Systems *Information Technologies* Service Representative immediately.

Installation

NOTE: Unless otherwise instructed, retain all hardware for re-assembly.

1. Turn off the 120 Series Monitor and disconnect the power cord from the monitor.
2. Use a flathead screwdriver to pry off the blank plugs inserted in the **Maternal SpO2** and **BP** connectors on the front panel of the monitor. Discard these plugs.
3. Remove the nine screws which secure the monitor top cover. Four screws are located on the bottom of the monitor and five screws are located in the back.
4. Remove the cover by sliding it toward the rear of the monitor.
5. Disconnect the display interconnect cable from the DSP Board at J5. (Refer to Figure 12-4.)
6. Disconnect the ribbon cable from the Recorder Board at J2. Leave the other end connected to the Main Motherboard. (Refer to Figure 12-5.)
7. Disconnect the Power Supply cable harness from the Recorder Board at J1. (Refer to Figure 12-5.)
8. Disconnect the ribbon cable from the membrane switch panel. Leave the other end connected to the DSP Board.
9. Remove the four screws which fasten the front bezel to the monitor—two on each side.
10. Gently tilt the bezel forward until it lays flat. Be careful not to disconnect the front end harness cable ferrite beads from their clips. The number of beads varies depending on which options are installed in your monitor. (Refer to Figure 12-6.)
11. Disconnect the Trim Knob cable assembly from the membrane switch panel.
12. Remove the two nuts holding the membrane panel assembly to the back side of the bezel assembly.
13. Remove the two screws and accompanying washers fastening the membrane switch panel metal tabs to the Recorder LED Board.
14. Push the membrane switch panel through the front panel. The switch panel will automatically disconnect from the Recorder LED Board.
15. Peel off the adhesive backing from the new membrane switch panel supplied with the kit.

16. Guide the metal tabs of the new membrane switch panel through the front panel. Secure the switch panel to the bezel with the nuts retained in step 12. Tighten to 8 in-lb.

17. Ensure that the Recorder LED Board is connected to the membrane switch panel. Using the screws and washers retained in 13, fasten the switch panel metal grounding tabs to the Recorder LED Board. Tighten to 4 in-lb.

18. Re-connect the Trim Knob cable assembly to the six pin connector on the membrane switch panel.

19. Ensure the front end harness cable ferrite beads are inserted in the corresponding clips. (Refer to Figure 12-6.)

20. Replace the front bezel and secure with all four screws.

21. Re-connect the ribbon cable from the DSP Board to the membrane switch panel.

22. Re-connect the Power Supply harness cable to J1 on the Recorder Board.

23. Re-connect the ribbon cable from the Main Motherboard to J2 on the Recorder Board.

24. Re-connect the display interconnect cable to the DSP Board at J5.

25. Remove the adhesive backing from the overlay label and carefully align over the front panel membrane switches. (Refer to Figure 12-7.)

26. Remove the Blood Pressure Board from its anti-static container.

27. Insert the Blood Pressure Board into the slot labeled J4 on the Main Motherboard. (Refer to Figure 12-8.)

28. Secure the board to the chassis using the two #6-32 x 3/8 screws provided in the kit.

29. Route the blood pressure tubing through the notch at the top of the DSP Board. (See Figure 12-8.)

30. Attach the tubes to the nipples located at the divider to the recorder cavity. (See Figure 12-8.)

31. Remove the hold-down cover for the front end boards. Three screws secure the top; one screw is located on the side panel.

32. *If FSpO2 is already installed* in your monitor, disconnect the FSpO2 harness cable from the FSpO2 Board at J1. Remove the Oximeter Carrier Board (No. 13551) from the Front End Motherboard; this board occupies the second slot from the left while facing the front of the monitor.

    If FSpO2 is not installed in your monitor, remove the MSpO2 Board and the Oximeter Carrier Board from their anti-static containers. If FSpO2 is installed in your monitor, you already have an Oximeter Carrier Board.

NOTE: The Oximeter Carrier Board is designed so that the MSpO2 Board mounts on one side, while the FSpO2 Board (if installed) mounts on the other side. The MSpO2 Board mounts on the *component* side—with the two ribbon cables.

33. Place the Oximeter Carrier Board on a static-free work surface so that J1 is on the bottom left and J4 is at the bottom right.
34. Align the MSpO2 Board over the Oximeter Carrier Board screw holes.
35. Use the washers and #4-40 x 1/4 screws provided in the kit to secure the MSpO2 Board to the Oximeter Carrier Board. Use the flat washer for the top left screw; use the shoulder washers for the remaining three screws. (Refer to Figure 12-9.)
36. Connect the ribbon cable from J2 on the Oximeter Carrier Board to JP5 on the MSpO2 Board.
37. Connect the ribbon cable from J5 on the Oximeter Carrier Board to JP1 on the MSpO2 Board.
38. Insert the Oximeter Carrier Board into the slots labeled J9 and J13 on the Front End Motherboard. (See Figure 12-10.)
39. Connect the front panel MSpO2 harness cable to J6 on the Oximeter Carrier Board.
40. The MSpO2 harness cable is already connected to the front panel in all 120 Series Monitors.
41. *If FSpO2 is installed in your monitor*, re-connect the front panel FSpO2 harness cable to J1 on the FSpO2 Board.
42. Replace the hold-down cover for the front end boards and secure with all four screws.
43. Locate switch pack SW1 on the Main Motherboard and set switches 6 and 7 to the OFF position. (See Figure 12-8.) This enables the MSpO2 and Blood Pressure Boards to communicate with Main Motherboard.
44. Ensure that the blood pressure tubing remains routed through the notch at the top of the DSP Board.
45. Replace the top cover and secure all nine screws.
46. Disconnect all cables from the monitor's front panel connectors.
47. Re-connect the monitor power cord.
48. *If FSpO2 is not installed* in the monitor, turn on the monitor and verify that the **NBP** and **MSpO2** parameter titles display on the screen. An "empty" pulse amplitude indicator should also appear in the MSpO2 area. (Refer to Figure 12-11.)

    If FSpO2 is installed in the monitor, connect both the MSpO2 and FSpO2 sensors. Turn on the monitor and verify that the **NBP**, **MSpO2**, and **FSpO2** parameter titles display on the screen. An "empty" pulse amplitude indicator should appear in both SpO2 areas. (Refer to Figure 12-11.)
49. Fill out the Update Installation Verification Form included in the kit. Be sure to include the monitor's serial number and catalog number on the form. Follow the instructions to fax the form to GE.

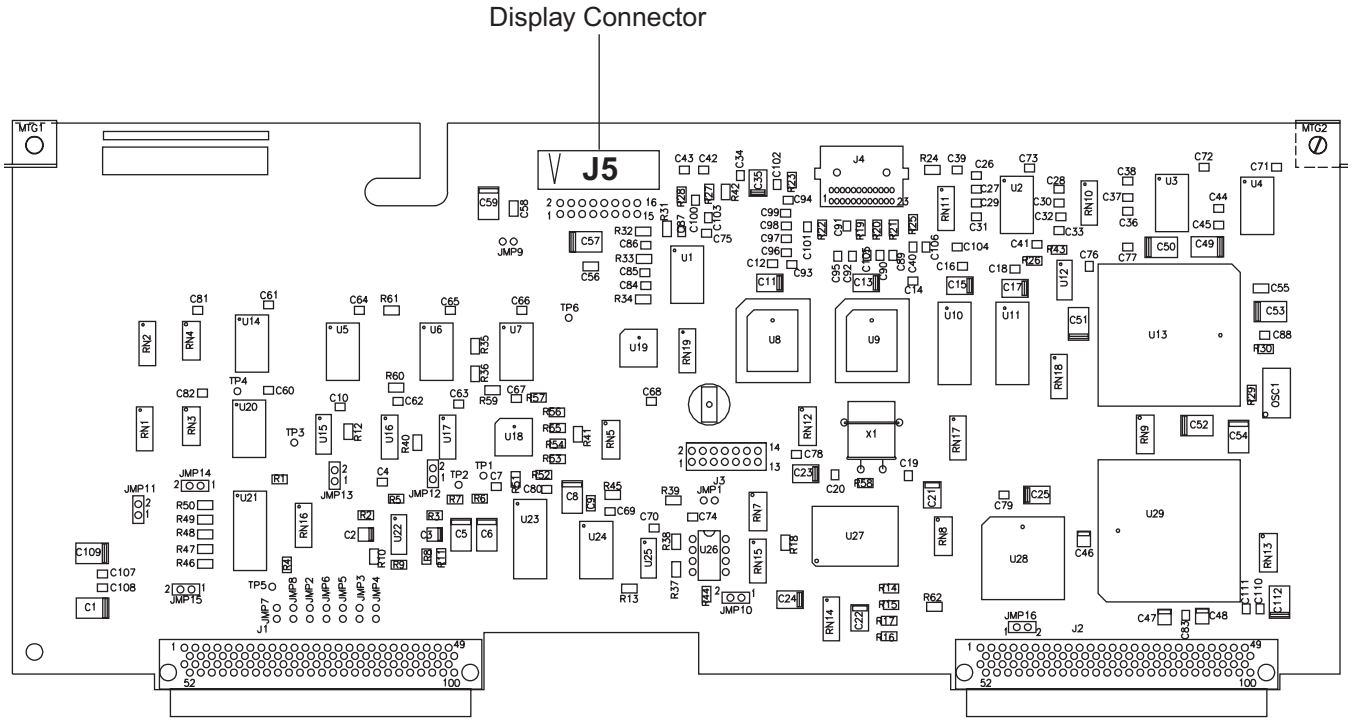


Figure 12-13. DSP Board

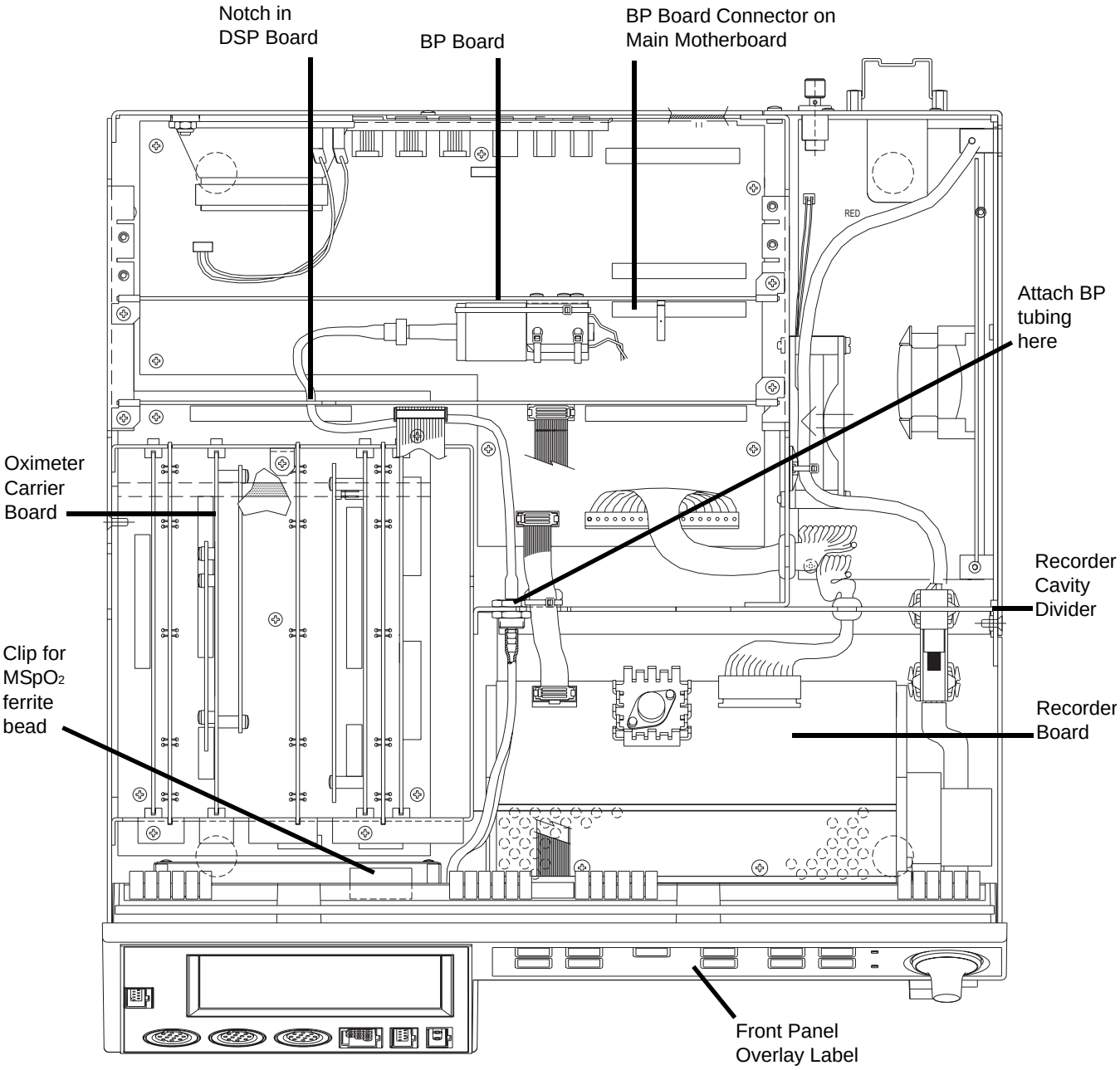


Figure 12-14. Top View

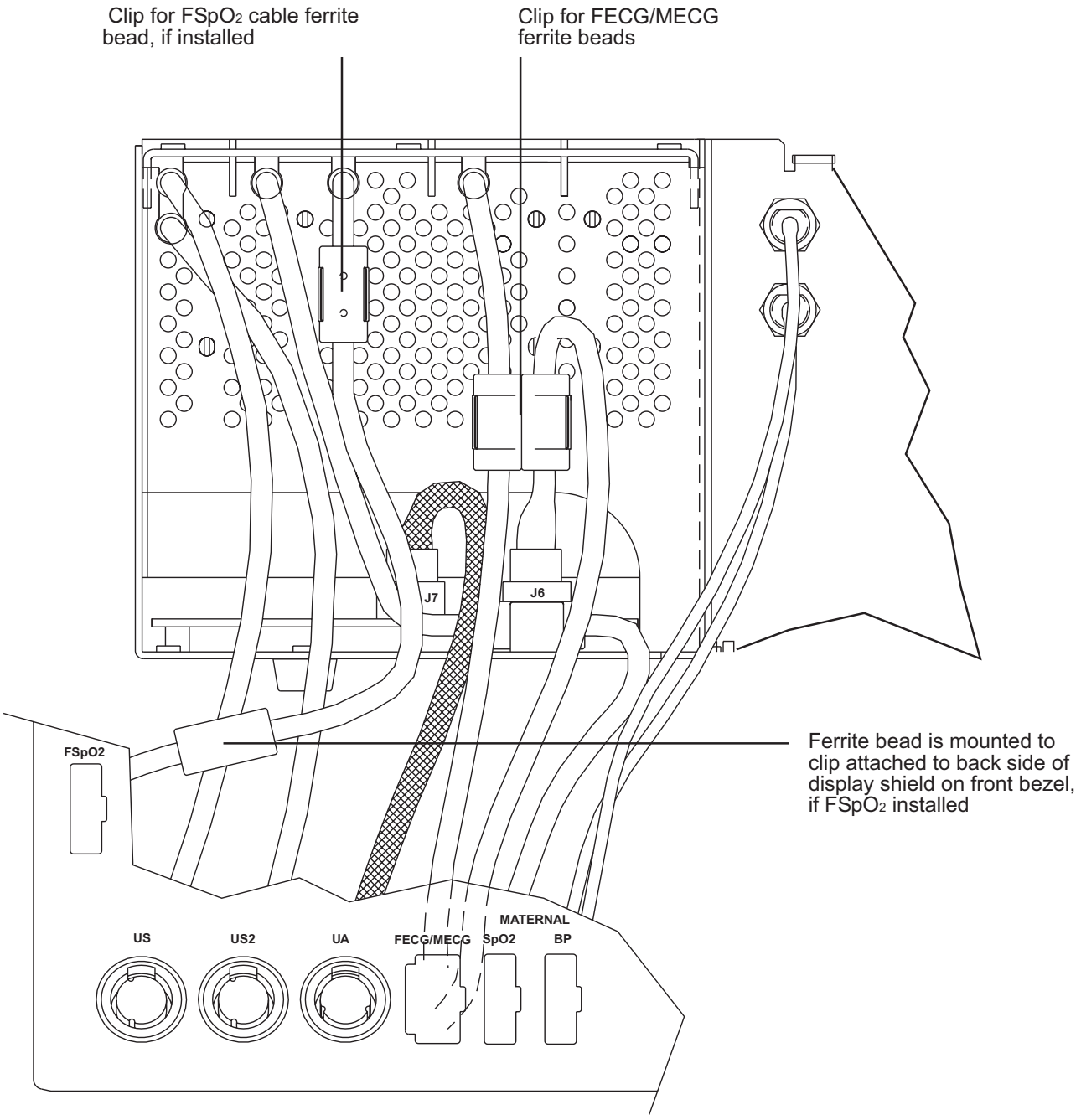


Figure 12-15. Partial Inside Front Panel with Bezel Removed

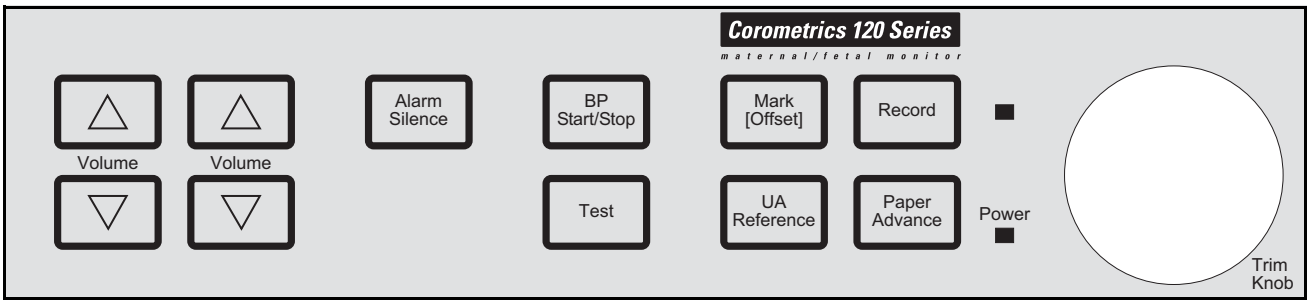


Figure 12-16. Front Panel Overlay Label

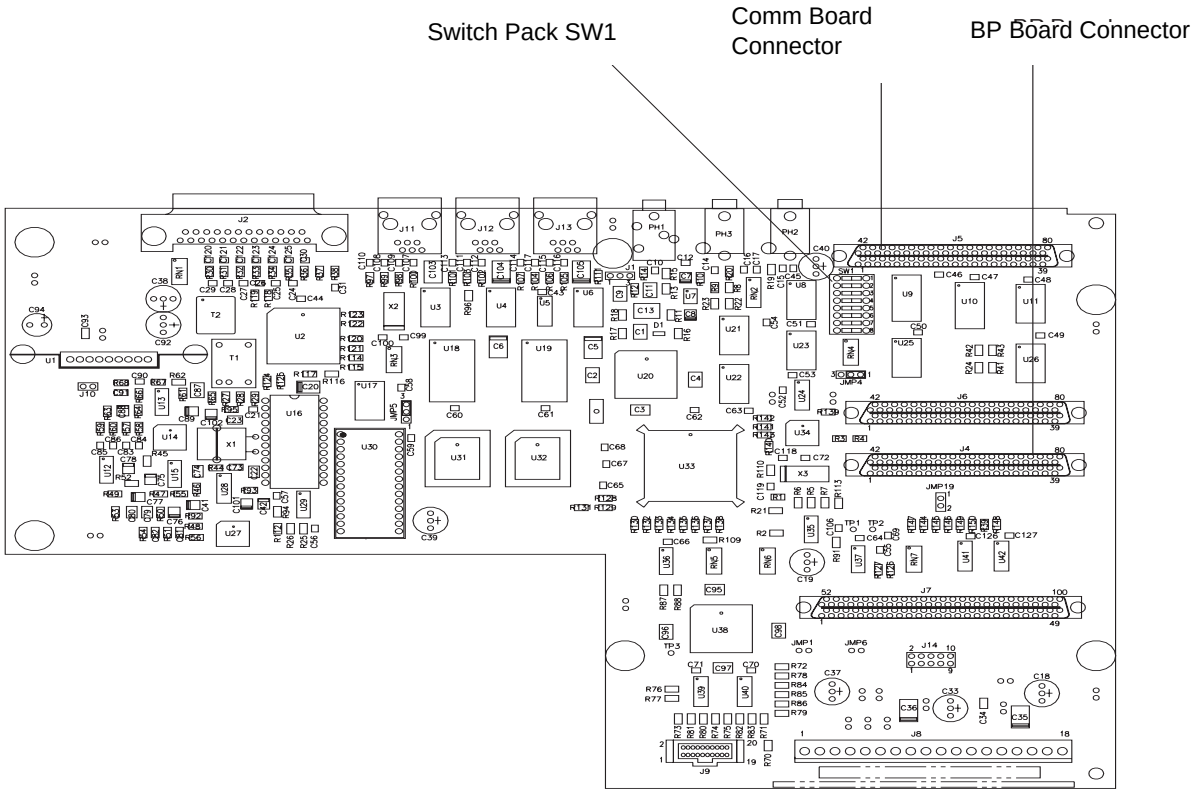


Figure 12-17. Main Motherboard

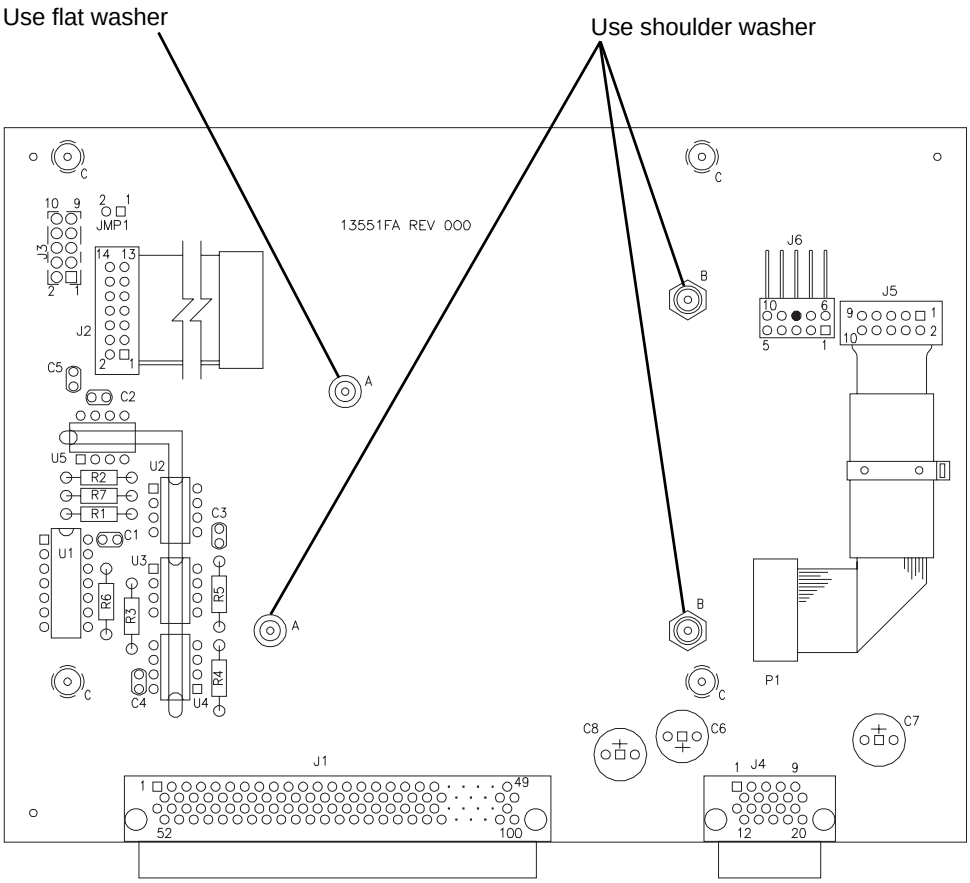


Figure 12-18. Oximeter Carrier Board

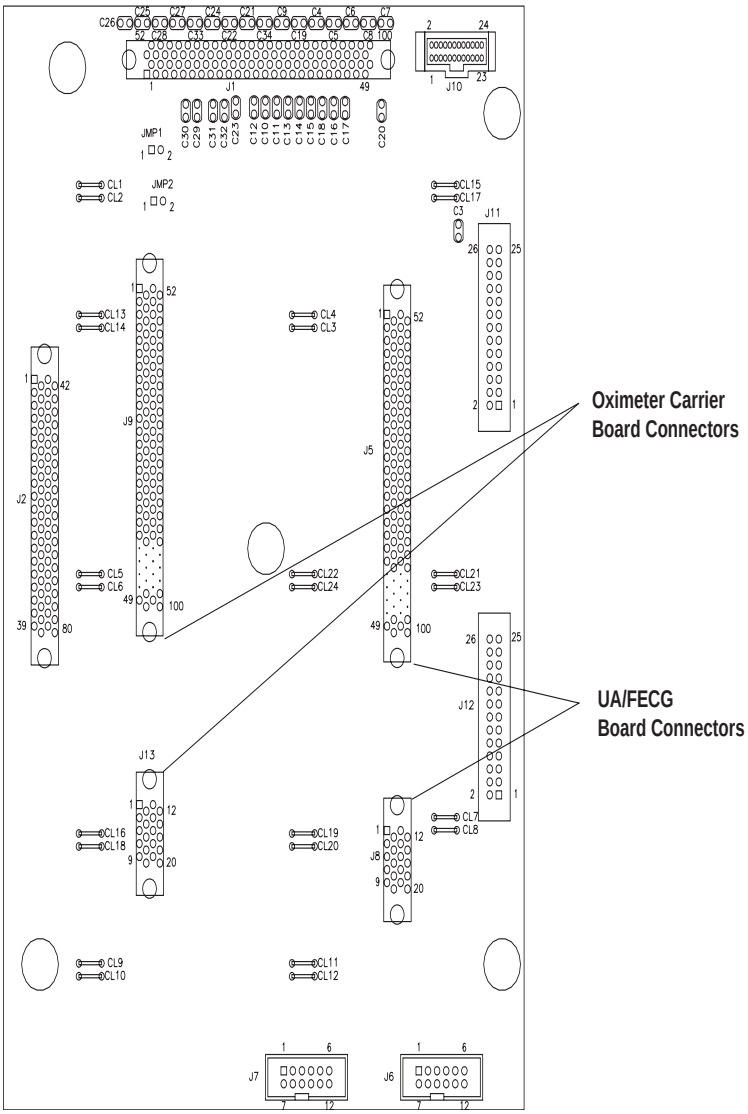


Figure 12-19. Front End Motherboard

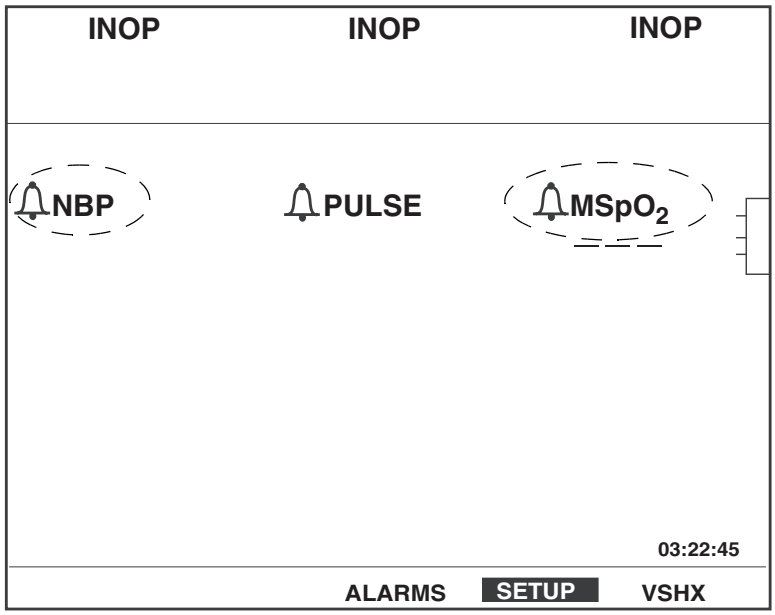


Figure 12-20. NBP and $MSpO_2$ Areas on Display

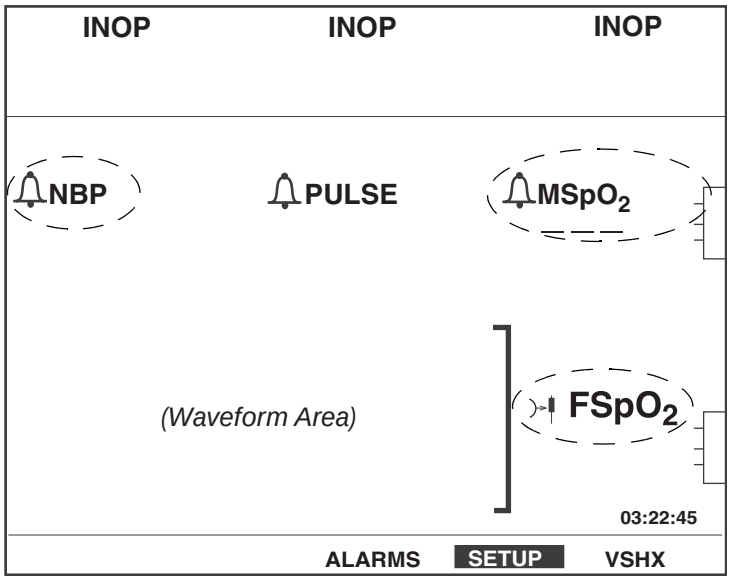


Figure 12-21. NSP, $MSpO_2$, and $FSpO_2$ Areas on Display

Masimo MSp0$_2$ Upgrade Kit

To upgrade from Nellcor MSp0$_2$ to Masimo MSp0$_2$, your monitor must be shipped to depot repair. Contact your local service center to make arrangements for this upgrade.

MECG Option Upgrade Kit

The MECG Option Upgrade Kit, adds MECG monitoring to Model 126/126F/128/128F Monitors. Installation instructions are provided in the kit; they are repeated here for informational purposes.

Unpacking

Unpack the upgrade kit and ensure it contains all items on the packing list. If something is missing, contact your GE Service Representative immediately.

Installation

1. Turn off the 120 Series Monitor and disconnect the power cord from the monitor.
2. Remove the nine screws which secure the monitor top cover. Four screws are located on the bottom of the monitor and five screws are located in the back.
3. Remove the cover by sliding it toward the rear of the monitor.
4. Remove the hold-down cover for the front end boards. Three screws secure the top; one screw is located on the side panel.
5. Remove the UA/FECG Board from the Front End Motherboard. The UA/FECG Board is the second board from the *right* in the front end section. (Refer to Figure 12-22.)
6. Remove the MECG Board from its anti-static container.
7. Mount the MECG Board onto the UA/FECG Board at the headers labeled J5 and J6. (Refer to Figure 12-1.)
8. Secure the MECG Board with the two screws provided in the kit. One screw is placed at the top left; the other at the bottom right. (See Figure 12-1.)
9. Re-insert the UA/FECG Board (with piggybacked MECG Board) into slots J5 and J8 on the Front End Motherboard. (Refer to Figure 12-24.)
10. Connect the front panel MECG harness cable to J7 on the MECG Board. (Refer to Figure 12-3.)
11. The MECG harness cable is already connected to the front panel in all 120 Series Monitors.
12. Replace the hold-down cover for the front end boards and secure with all four screws.
13. Locate switch pack SW1 on the Main Motherboard and ensure switch 8 is set to the OFF position. (See Figure 12-26.) This switch activates communication between the Main Motherboard and the MECG Board.
14. Replace the top cover and secure all nine screws.
15. Disconnect all cables from the monitor’s front panel connectors.
16. Re-connect the monitor power cord and turn on the monitor.

17. Use the Trim Knob control to access the MHR/P Setup screen, then select MECG as the source. (Refer to Figure 12-27.)

18. Exit the setup screen, then verify that the **MECG** parameter title displays. (Refer to Figure 12-28.)

19. Fill out the Update Installation Verification Form included in the kit. Be sure to include the monitor's serial number and catalog number on the form. Follow the instructions on the form to fax ***or*** mail the form to GE

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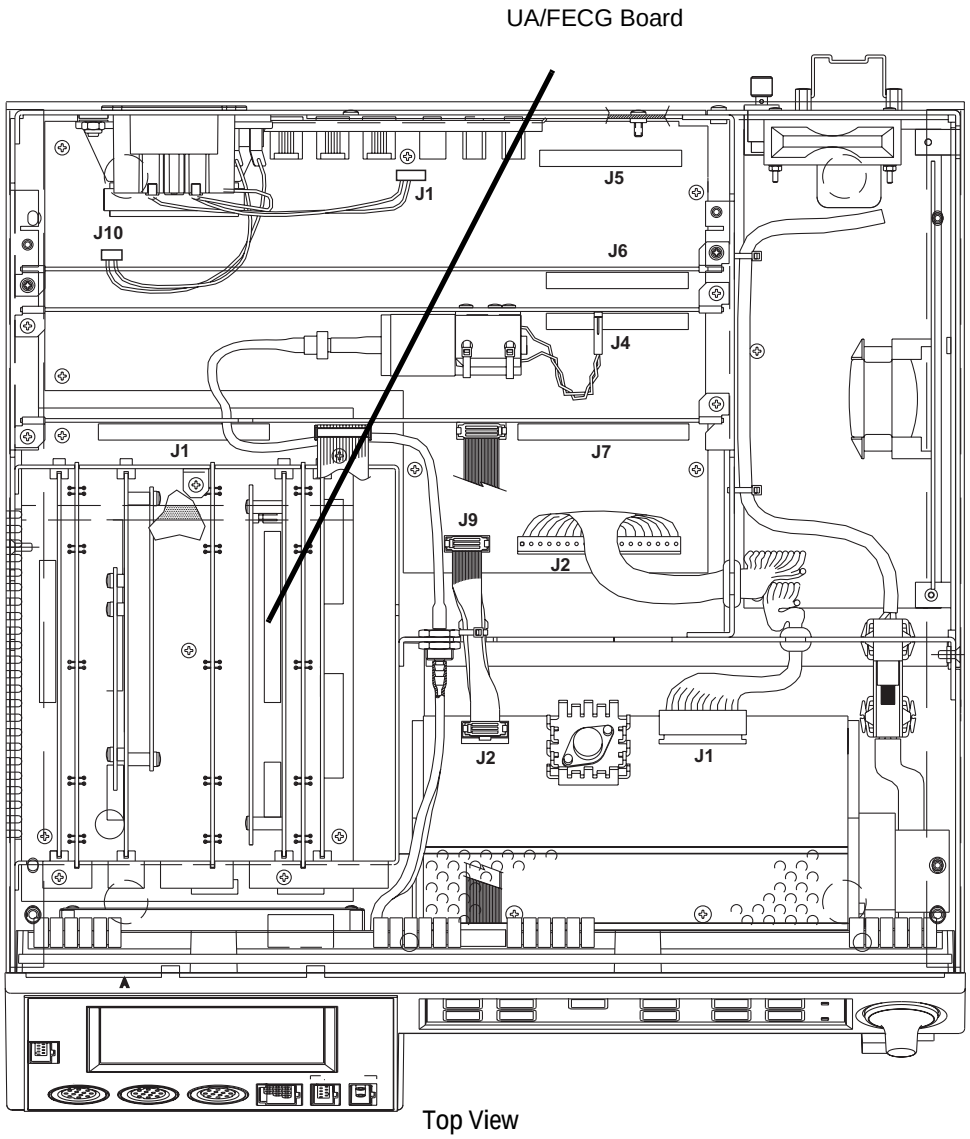


Figure 12-22. UA/FECG Board

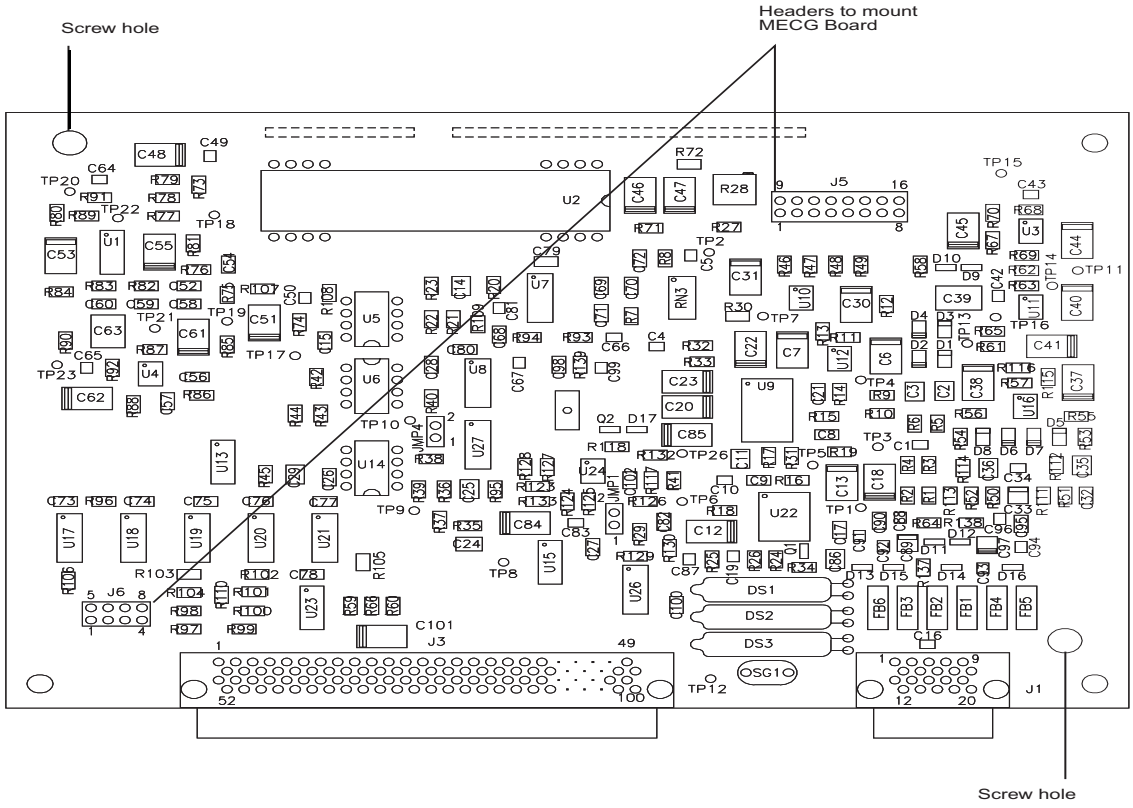


Figure 12-23. UA/FECG Board

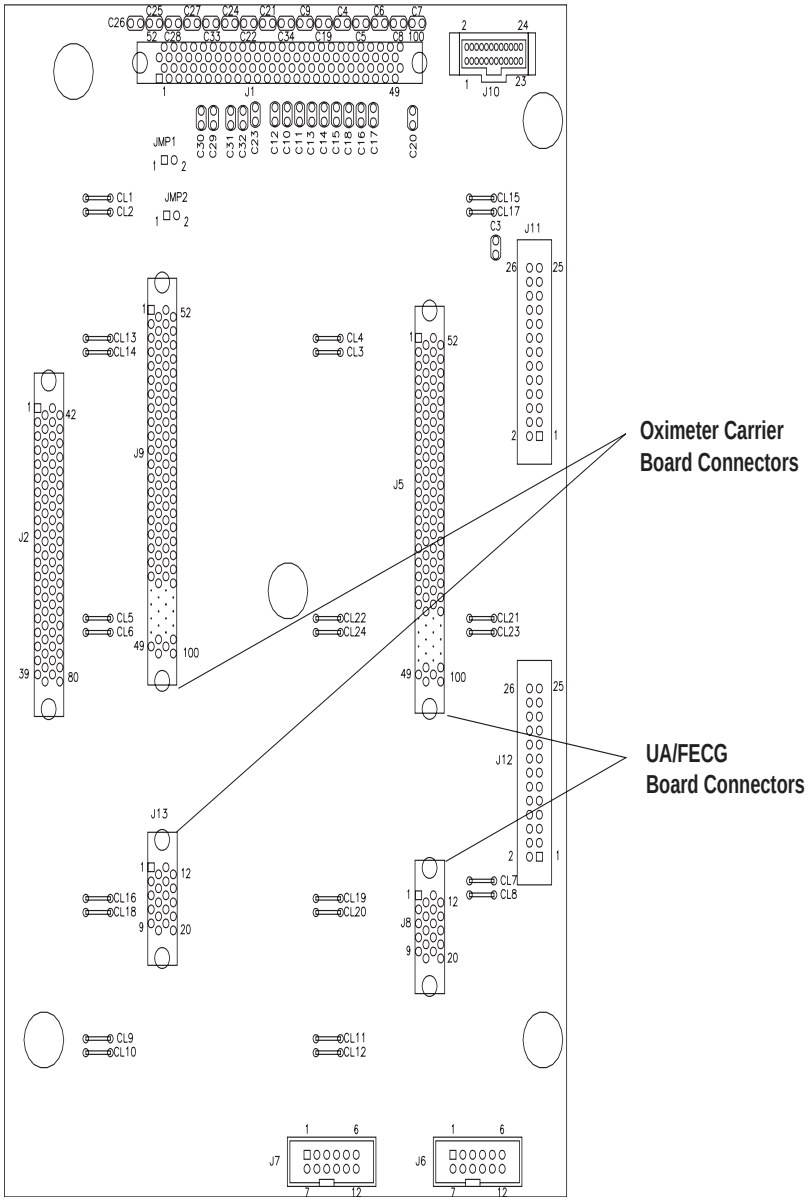


Figure 12-24. Front End Motherboard

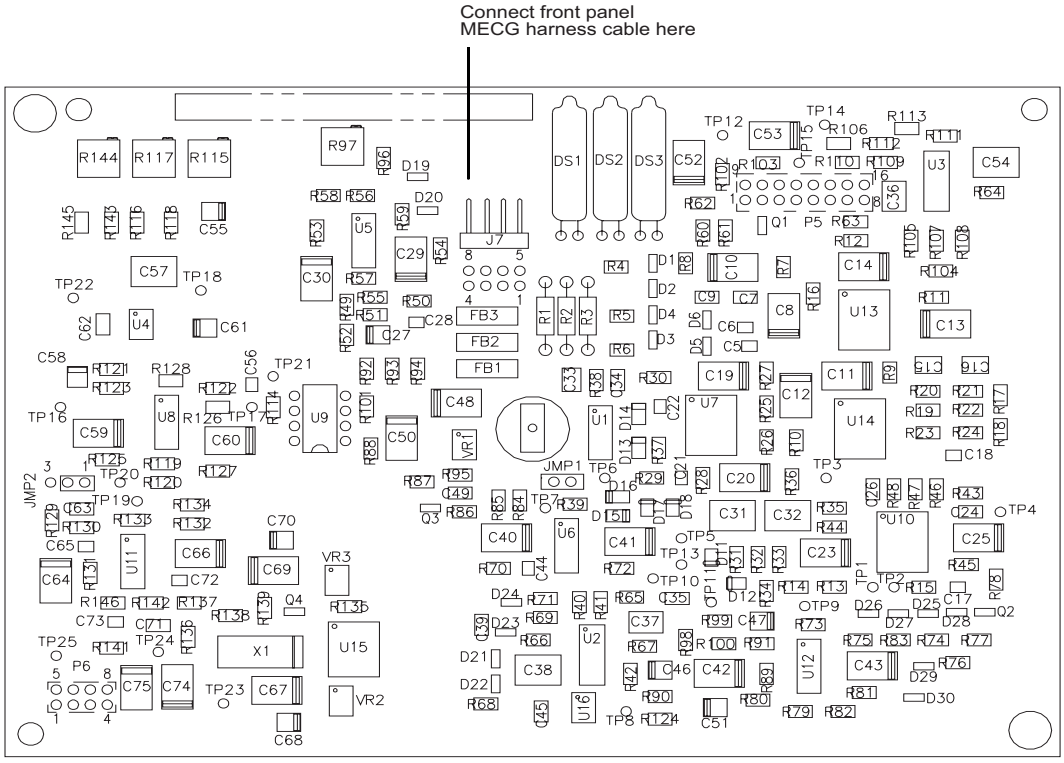


Figure 12-25. MECG Board

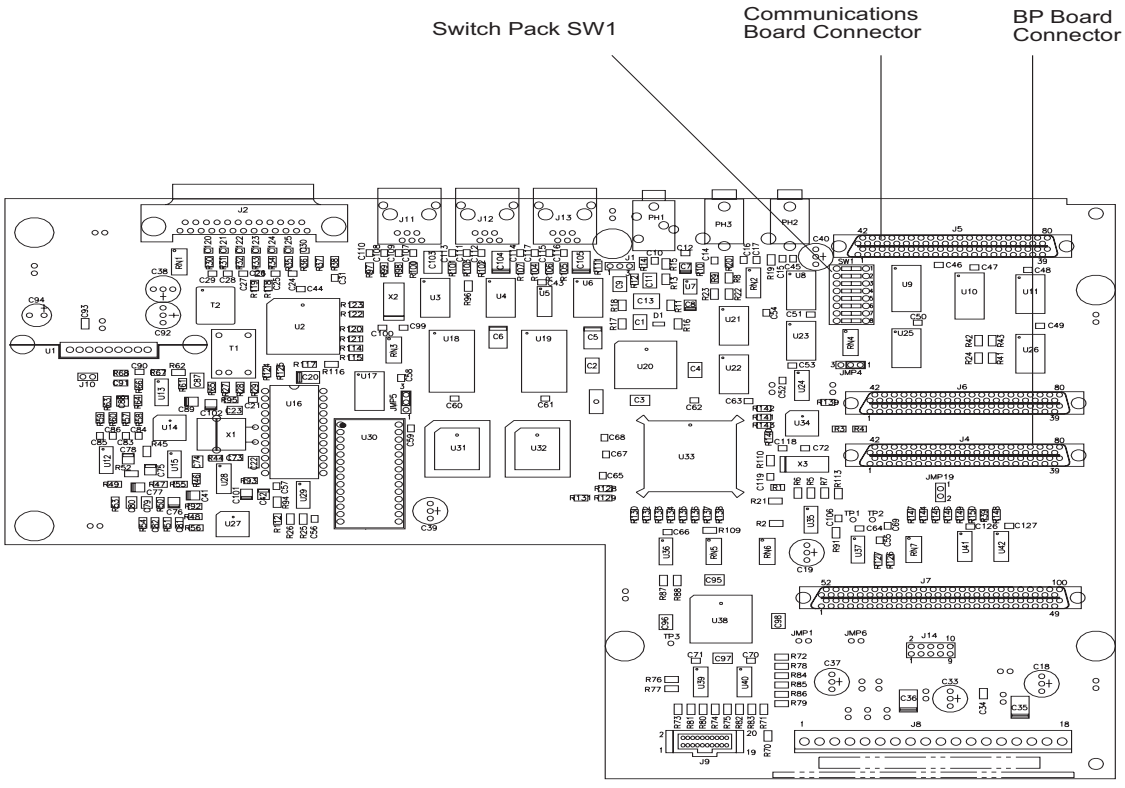


Figure 12-26. Main Motherboard

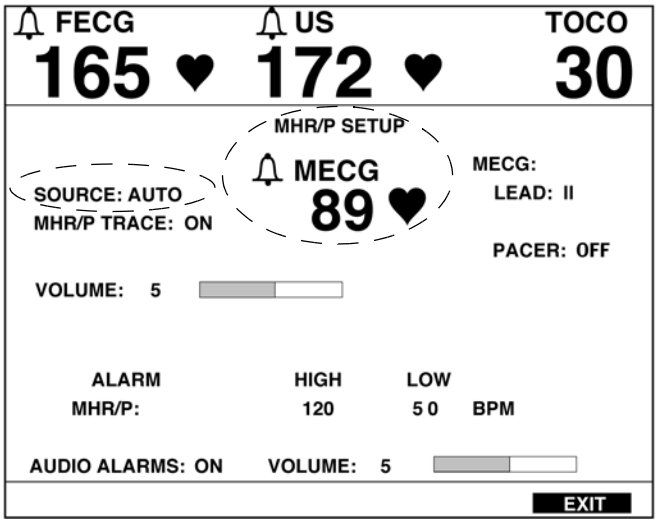


Figure 12-27. MHR/P Setup Screen

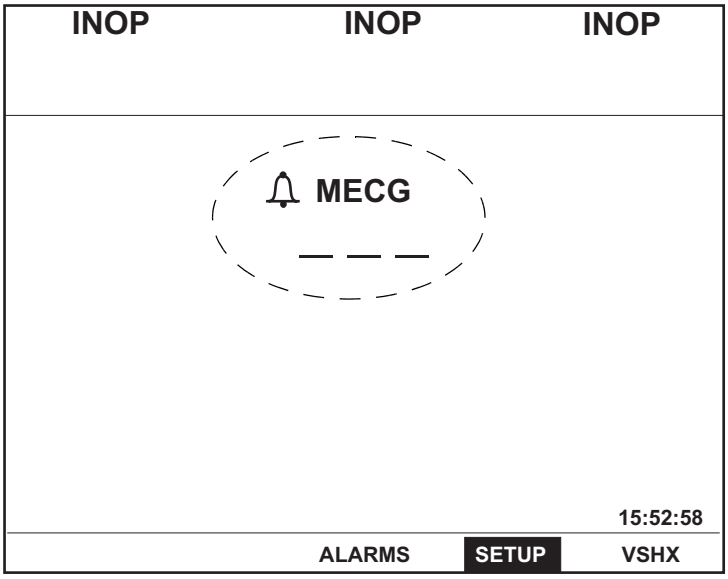


Figure 12-28. MHR Area on Display

Software Version 3.5

You can upgrade to software version 3.5 by using the Flasher Software Utility or by replacing the EEPROMS. Refer to "Chapter 14, Replacement Parts" for kit numbers.

Flasher Software Utility Upgrade Method

Flasher is a software utility program which uses one of the monitor's RS-232 serial ports to upgrade to a newer software release. Each Flasher disk contains the software upgrade for one-time use only. (In other words, you need an individual Flasher disk for each monitor being upgraded.) The kit comes with an instruction manual for running the Flasher program.

EEPROM Replacement Method

1. Turn off the 120 Series Monitor and disconnect the power cord from the monitor.
2. Remove the nine screws which secure the monitor top cover. Four screws are located on the bottom of the monitor and five screws are located in the back.
3. Disconnect the display interconnect cable from the DSP Board at J5. (Refer to Figure 12-30 and Figure 12-1.)
4. Disconnect the membrane switch panel ribbon cable from the DSP Board at J4. (Refer to Figure 12-30 and Figure 12-1.)
5. Disconnect the blood pressure tubing from the nipples located at the divider to the recorder cavity. Unthread the tubing from the notch at the top of the DSP Board. Leave the other end of the tubing attached to the Blood Pressure Board. (Refer to Figure 12-30.)
6. Remove the two screws which fasten the Blood Pressure Board to the monitor chassis.
7. Remove the Blood Pressure Board and set aside on an anti-static surface.
8. Remove the two screws which fasten the DSP Board to the monitor chassis.
9. Remove the DSP Board and set aside on an anti-static surface.
10. Locate and note the orientation of flash ROMs U31 and U32 on the Main Board. (Refer to Figure 12-31.) Using the PLCC extractor, carefully remove U31 and U32.
11. Locate and note the orientation of flash ROMs U8 and U9 on the DSP Board. (Refer to Figure 12-1.) Using the PLCC extractor, carefully remove U8 and U9.

NOTE: Each flash ROM in the kit is labeled with an assembly number, software release date, and lot code. Use the assembly number for identification purposes during this procedure.

12. Remove the four flash ROMs from their anti-static containers and mount them according to Table 12-1.

CAUTION

MOUNTING—When mounting a flash ROM, make sure the label side is up, then apply even downward pressure to firmly seat the IC in the socket. You will feel when the IC snaps into place and you may hear a "click."

Table 12-1. Flash ROM Locations

Assembly No.	Board	Ref.
14135C	DSP	U8
14135D	DSP	U9
2004411-002	Main	U31
2004412-002	Main	U32

13. Replace the DSP Board and secure with both screws.
14. Replace the Blood Pressure Board and secure with both screws.
15. Route the blood pressure tubing through the notch at the top of the DSP Board.
16. Attach the tubes to the nipples located at the divider to the recorder cavity.
17. Re-connect the membrane switch panel ribbon cable to the DSP Board at J4.
18. Re-connect the display interconnect cable to the DSP Board at J5.
19. Replace the top cover and secure all nine screws.
20. Re-connect the monitor power cord and turn on the monitor.
21. Use the Trim Knob control to access the first Service screen. (Refer to Figure 12-32.)
22. Verify that the CPU version is **V3.5** and the DSP version is **03.07**. (Refer to Figure 12-32.)
23. Fill out the Update Installation Verification Form provided in the kit. Be sure to include the monitor's serial number and catalog number on the form. Follow the instructions on the form to fax ***or*** mail the form to GE.
24. Re-use the antistatic packaging to mail the old flash ROMs to the factory service group at the following address:

    ATTN Factory Service
    GE Medical Systems *Information Technologies*
    100 Marquette Drive
    Jupiter, FL 33468

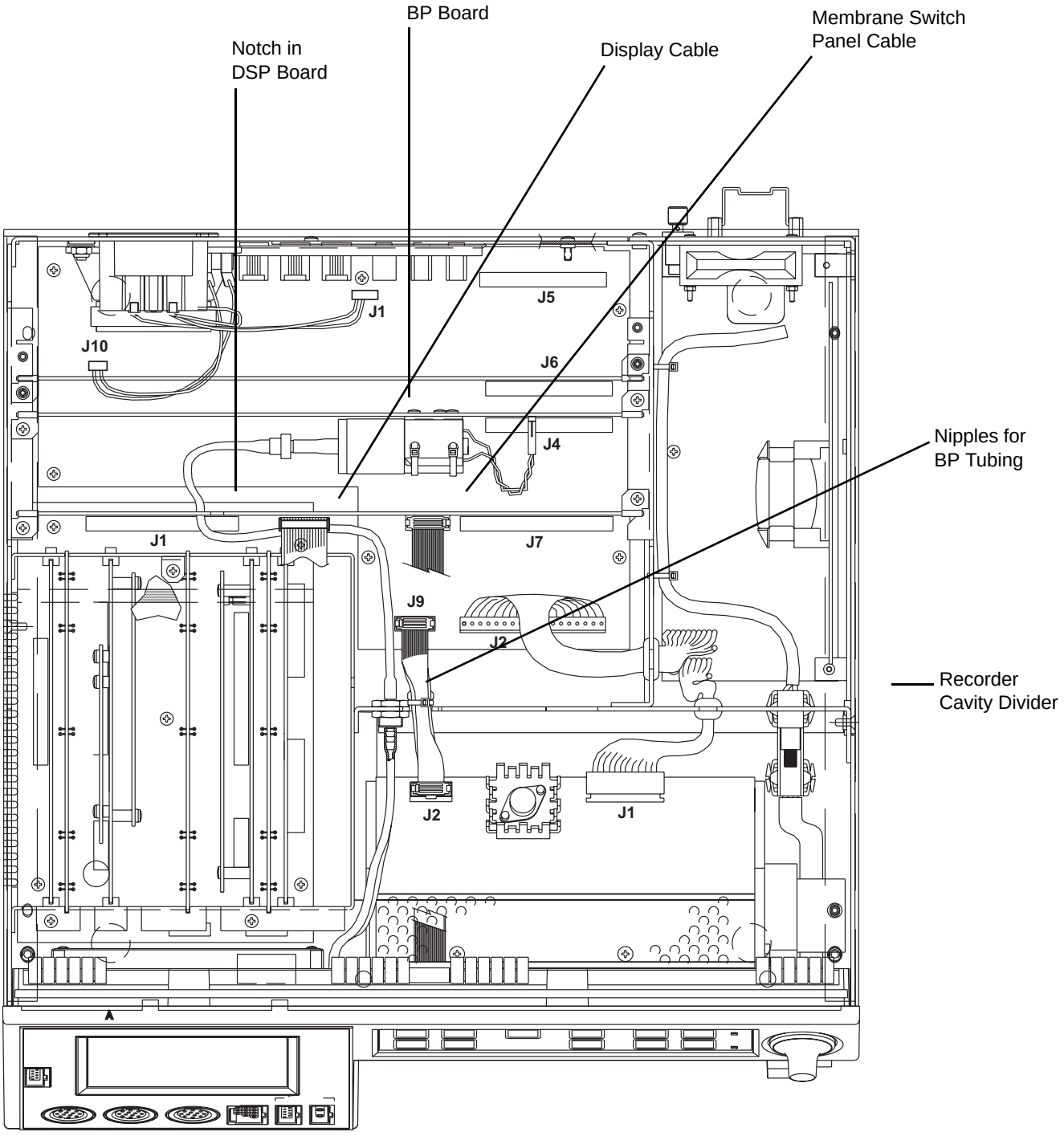


Figure 12-29. Top View

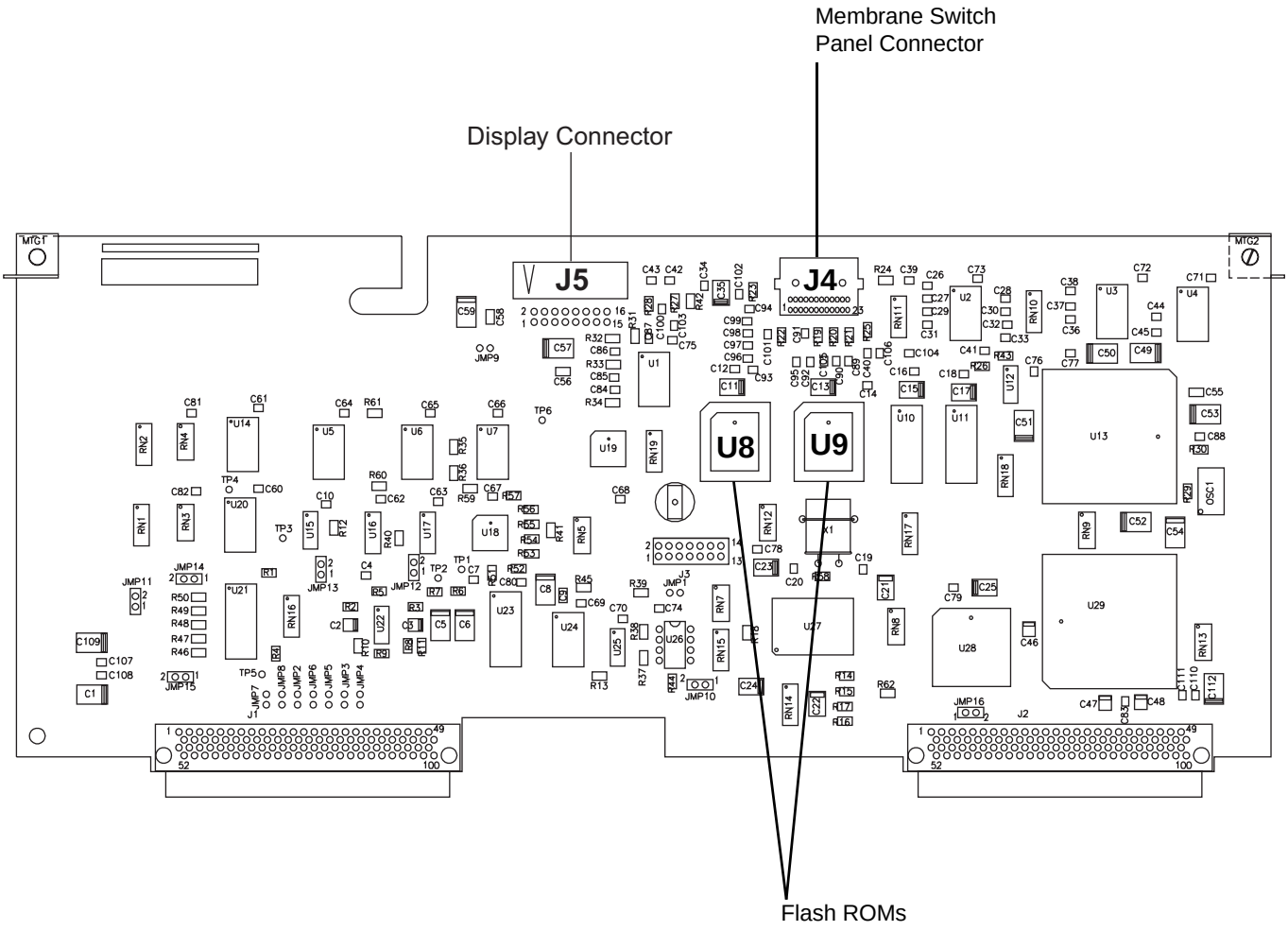


Figure 12-30. DSP Board

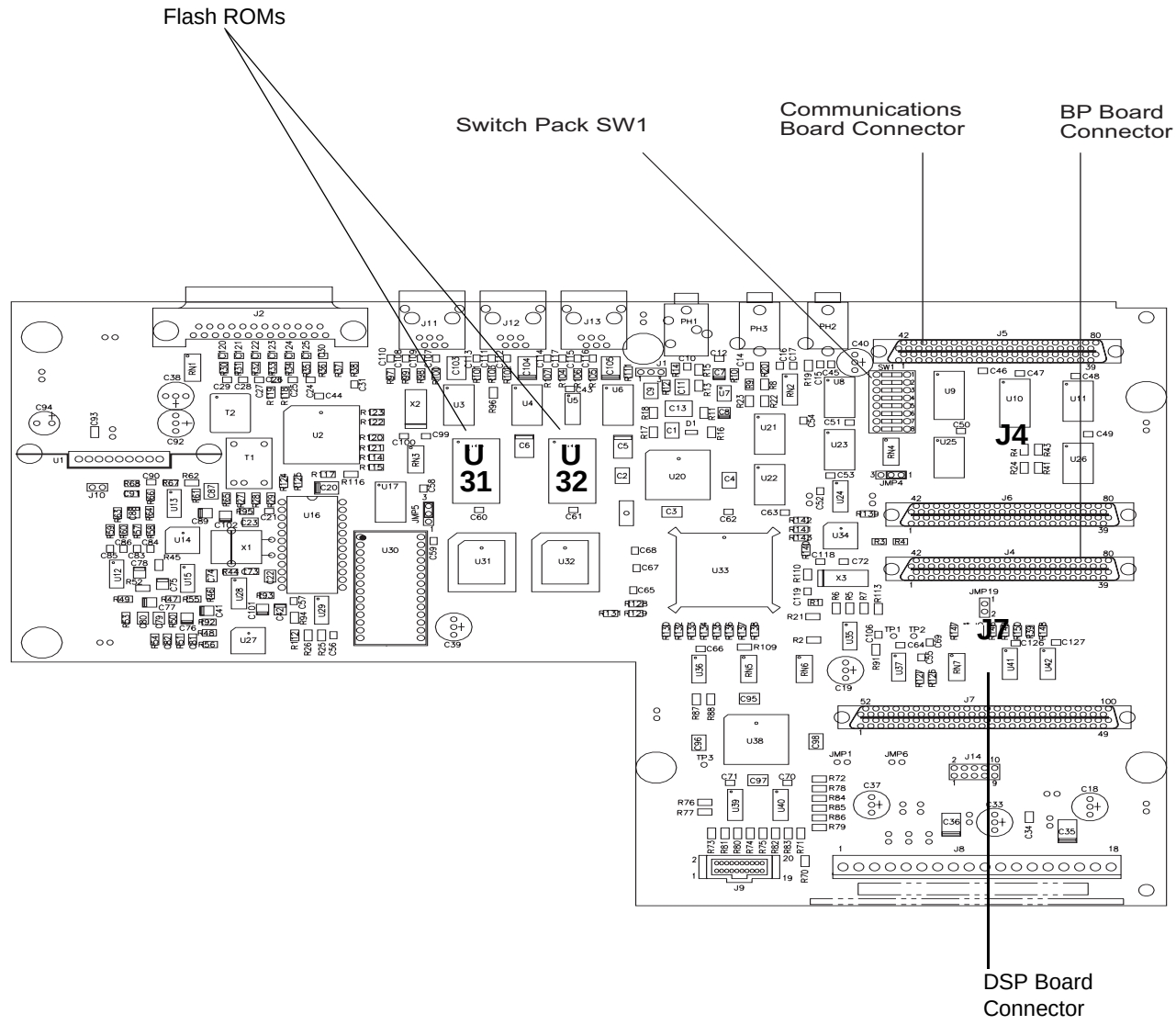


Figure 12-31. Main Motherboard

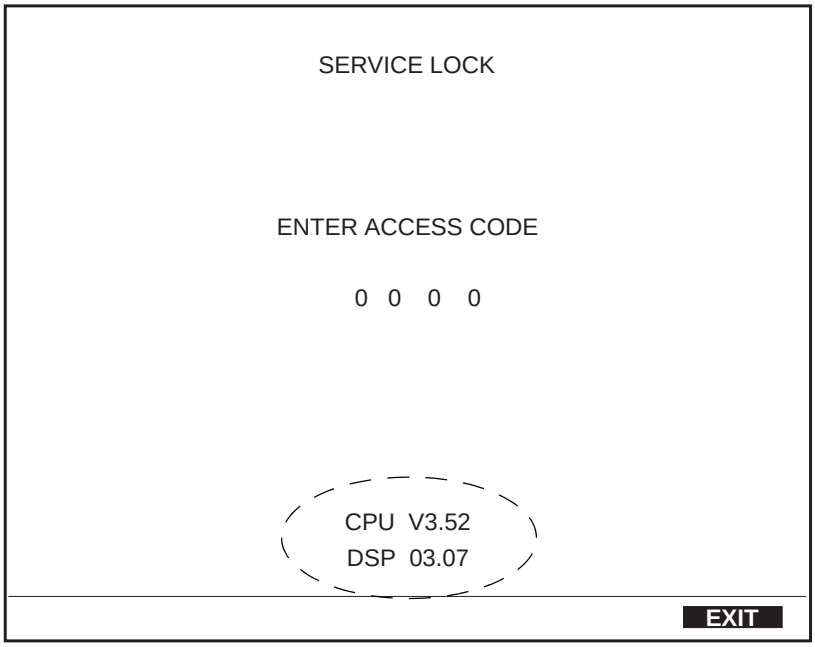


Figure 12-32. Service Screen

Display Upgrade

To upgrade to a 3.5” x 4.5” display, refer to “Chapter 14, Replacement Parts” for kit information.

Fetal Movement Detection

Flasher is a software utility program which uses one of the monitor’s RS-232 serial ports to install a purchased option such as fetal movement detection. Each Flasher disk contains the software upgrade for one-time use only. (In other words, you need an individual Flasher disk for each monitor being upgraded.) The kit comes with an instruction manual for running the Flasher software. The available kits are found in “Chapter 14, Replacement Parts”.

Chapter 13

Technical Specifications

This section contains a detailed list of the technical specifications for the 120 Series Monitor.

This chapter lists specifications for the following:

General Monitor 13-2
Operating Modes 13-3
Strip Chart Recorder 13-8

General Monitor

Table 13-1. General Monitor Technical Specifications

Category	Technical Specifications				
Power Requirements					
Nominal Line Voltage:	100VAC	120 VAC	220 VAC	230 VAC	240 VAC
Line Frequency:	50/60 Hz	50/60 Hz	50/60 Hz	50/60 Hz	50/60 Hz
Power Consumption (maximum):	100 W	100 W	0.4 A	0.4 A	0.4 A
Chassis Leakage:	<300 µA				
Physical Characteristics					
Height:	6.7 in (17.0 cm)				
Width:	16.5 in (41.9 cm)				
Depth:	17.3 in (43.9 cm)				
Weight:	24.0 lbs (10.9 kg) approx.				
⚠ **Environmental Conditions**	**Operating**			**Storage**	
Monitor:					
Ambient Temperature:	50°F to 104°F (10°C to 40°C)			14°F to 131°F (–10°C to 55°C)	
Relative Humidity:	10% to 95%, non-condensing			0% to 95%, non-condensing	
Atmospheric Pressure:	700–1060 mbar (525–795 mmHg)			700–1060 mbar (525–795 mmHg)	
Strip Chart Paper[a]:					
Ambient Temperature:	50°F to 104°F (10°C to 40°C)			< 80°F (< 26.5°C)	
Relative Humidity:	30% to 70%, non-condensing			45% to 65%, non-condensing	
Atmospheric Pressure:	700–1060 mbar (525–795 mmHg)			700–1060 mbar (525–795 mmHg)	
Certification					
ANSI/AAMI EC13-1992:	Complies with all areas except those listed below: 3.1.2.1e: Heart Rate Meter Accuracy and Response to Irregular Rhythm (not tested) 3.2.6.1: Range of QRS wave amplitude and duration 3.2.7: Range and accuracy of heart rate meter (4.2.7f :input rate of 300 BPM.) 3.2.8.1: Lower Alarm Limit (The lowest alarm limit on the 120 Series is 35 BPM.)				
UL-2601.1:	3.2.9.8c: Impulse Response 4.2.9.7 Output Display a) Channel Width Classified to UL-2601.1				
CUL:	Medical electrical equipment classified by Underwriter's Laboratories, Inc., with respect to fire, shock, and mechanical hazards in accordance with UL-2601.1. Classified with respect to electric shock, fire, mechanical, and other specified hazards only, in accordance with CAN/CSA C22.2 No. 601.1				

[a] *Paper operating environmental conditions are for a period of less than one month. Paper storage environmental conditions are for extended storage.*

Operating Modes

Table 13-2. Operating Mode Specifications		
FECG Mode		
Technique:	Peak detecting, beat-to-beat cardiotachometer	
Heart Rate Counting Range:	30–240 BPM	
Heart Rate Resolution:	±1 BPM	
Artifact Elimination:	Selectable, ±25 BPM artifact rejection	
Countable Input Signal Range:	15 µV to 2 mV peak-to-peak	
Offset Voltage Tolerance (Differential):	±300 mVdc maximum	
Maximum Common Mode Voltage:	20 V peak-to-peak	
Preamplifier Bandwidth:	1–100 Hz	
Common Mode Rejection:		
Balanced:	> 120 dB at mains frequency, with patient cable	
Unbalanced 5kΩ RA or LA:	> 110 dB at mains frequency	
Input Equivalent Noise:	< 10 µV peak-to-peak	
Input Impedance:		
Differential:	> 10 MΩ	
Common Mode:	> 20 MΩ	
Mains Frequency Rejection:	> 40 dB	
Leakage Current:	< 60 µA at 254 VAC, electrically isolated	
Isolation, Mains-to-Patient:	> 4 kVAC	
Ultrasound Mode		
Technique:	Pulsed Doppler with autocorrelation processing	
Transducer Type:	9-crystal	
Pulse Repetition Frequency:		
Single Ultrasound Mode:	4 kHz	
Dual Ultrasound Mode:	2 kHz	
Pulse Duration:	92 µs	
Transmitter Frequency:	1.151 MHz	
Spatial-Peak Temporal Average Intensity:	Ispta < 10 mW/cm^2	
Spatial-Average Temporal Average Intensity:		
Focal 20 dB Beam Area:	Isata< 5 mW/cm^2	
Peak Instantaneous Intensity:	16.6 cm^2, at a range = 7 cm	
Peak-Negative Acoustic Pressure:	1.8 mW/cm^2	
Heart Rate Counting Range:	p < 10.0 kPa	
Leakage Current:	50–210 BPM	
	< 10 µA at 120–240 VAC, isolated by transducer	
Uterine Activity Mode	**Strain Gauge**	**Tocotransducer**
Range:	0–100 mmHg	0–100 relative units
Resolution:	1 mmHg	1 relative unit
Bandwidth:	dc to 0.5 Hz	dc to 0.5 Hz
Excitation Voltage:	+4.0 Vdc	
Zero Set Temperature Drift:	< 0.1 mmHg/°C (0.013 kPa/°C), excluding transducer	
Leakage Current:	< 60 µA at 254 VAC, electrically isolated	

Table 13-2. Operating Mode Specifications (Continued)	
MECG Mode	
Technique:	Peak detecting, beat-to-beat cardiotachometer
Maternal ECG Electrode Type:	Medtronic 1700-003 or equivalent
Leads Available:	I, II, and III
Heart Rate Counting Range:	30–240 BPM
Heart Rate Resolution:	±1 BPM
Heart Rate Averaging:	1 second average
Heart Rate Update Rate:	> 1 update per second
Countable Input Signal Range:	< 0.5 mV to 5 mV peak-to-peak
Baseline Drift:	< 0.5 mV RTI
Tall T-wave Rejection:	< 0.8 **x** QRS amplitude
Heart Rate Meter Response Time:	
80–120 BPM Step Increase:	< 2 seconds
80–40 BPM Step Decrease:	< 3 seconds
Alarm Time for Tachycardia 80–200 BPM:	< 10 seconds (high alarm limit at 100 BPM)
Offset Voltage Tolerance (Differential):	±300 mVdc maximum
Maximum Common Mode Voltage:	20 V peak-to-peak
Preamplifier Bandwidth:	0.6 to 40 Hz
Common Mode Rejection:	
Balanced:	> 80 dB at mains frequency, with patient cable
Unbalanced 5K RA or LA:	> 50 dB at mains frequency
Input Equivalent Noise:	< 30 µV peak-to-peak
Input Impedance:	
Differential:	> 2.5 MΩ
Common Mode:	> 10 MΩ
Mains Frequency Rejection:	> 40 dB
Leakage Current:	< 60 µA at 254 VAC, with cable, electrically isolated
Isolation, Mains-to-Patient:	> 4 kVAC
Leads Off Detection:	dc current < 0.1 µA
Alarms:	
Audio:	Alternating 1.5 second chimes (773 Hz and 523 Hz)
Visual:	Flashing heart rate numeric or message
Limits:	User-selectable high and low maternal heart rate
Technical:	Leads off
Tachycardia Response Time:	< 8 seconds
Pacemaker Detection/Rejection:	
Input Voltage Range:	±2.5 mV to ±700mV
Input Pulse Width:	0.1 to 2 ms
Pulse Rise/Fall Time:	< 10% of pulse width; not greater than 100 µs
Overshoot/Undershoot:	2 mV (see caution below)

CAUTION

Excessive overshoot time of pacemaker pulse may cause false QRS detection.

Table 13-2. Operating Mode Specifications (Continued)	
Maternal Blood Pressure Mode	
Technique:	Oscillometric. Microprocessor software eliminates most ambient noise and motion artifact.
Blood Pressure Range:	20–255 mmHg (2.7–34.0 kPa)
Pulse Rate Range:	40–240 BPM
Blood Pressure Accuracy:	±5 mmHg (0.7 kPa) with a standard deviation no greater than 8 mmHg (1.1 kPa)
Pulse Rate Accuracy:	±2 BPM or ±2 % (whichever is greater)
Cuff Inflation:	Initial inflation to 160 mmHg (21.3 kPa). Subsequent inflation approximately 30 mmHg (4.0 kPa) greater than the previous systolic pressure.
Cuff Deflation:	Automatic
Safety Features:	Automatic cuff deflation if: cuff pressure exceeds the overpressure limit of 285 ± 15 mmHg (37.3 ± 2 kPa); or maximum reading determination time is exceeded (not to exceed AAMI /ANSI SP10-1992 limit of 180 s); or safety timer detects microprocessor failure. Auto mode minimum 30-second delay from the end of one determination to the beginning of another to allow for venous return.
Display/Record:	Systolic, diastolic, and mean pressure; pulse rate
Alarms (audible and visual):	
Audio:	Alternating 1.5 second chimes (773 Hz and 523 Hz)
Visual:	Flashing pressure numeric or message
Limits:	User-selectable high and low systolic, diastolic, and mean pressures; User-selectable high and low pulse rate
Technical:	Cuff errors, connection errors, insufficient signal, excessive inflation or determination times, overpressure, hose errors, excessive motion, communication problem, or self-test failure.
Compliance:	The 120 Series' blood pressure module complies with the American National Standard for Electronic or Automated Sphygmomanometers [AAMI/ANSI SP10-1992]. Blood pressure measurements determined with this device are equivalent to those obtained by a trained observer using the cuff/stethoscope method, within the limits prescribed by the American National Standard for Electronic or Automated Sphygmomanometers.
Fetal Pulse Oximetry Mode (Nellcor)	
Technique:	Spectrophotometry and plethysmography.
Sensor Type:	Nellcor Puritan Bennett (Model FS-14B only)
Saturation Range:	10–100%
Saturation Accuracy:	%SpO_2 ±1 standard deviation:
(with Nellcor Puritan Bennett FS-14B Sensor)	Reproducibility is 1 standard deviation = 6%. Nominally, 68% of the measurements across the population will be within ±1 standard deviation.
Wavelengths:	
Red:	735 nm, nominal
Infrared:	890 nm, nominal

Table 13-2. Operating Mode Specifications (Continued)

Maternal Pulse Oximetry Mode (Nellcor)	
Technique:	Spectrophotometry and plethysmography.
Sensor Type:	Nellcor Puritan Bennett (D-25 or D-25L recommended)
Saturation Range:	0–100 %
Pulse Rate Range:	30–250 BPM
Saturation Accuracy:	$\%SpO_2$ ±1 standard deviation[1]:
(with Nellcor Puritan Bennett D-25 Sensor)	70–100 % ±2 digits
	50–69 % ±3 digits
Pulse Rate Accuracy:	0–49% (unspecified)
	±3 BPM
Wavelengths:	
Red:	660 nm, nominal
Infrared:	920 nm, nominal
Response Time:	User-selectable: slow, normal, and fast averaging modes.
Alarms (audible and visual):	
Audio:	Alternating 1.5 second chimes (773 Hz and 523 Hz)
Visual:	Flashing $\%SpO_2$ numeric or message
Limits:	User-selectable high and low SpO_2; User-selectable high and low pulse rate
Technical:	Sensor errors, connection errors, insufficient signal, excessive motion, communication problem, internal calibration error, or self-test failure.

1) *The accuracy of a given oxygen range is valid for only 68% of the data points taken and the remaining 32% of the data points are not counted in the specification.*

Maternal Pulse Oximetry Mode (Masimo)	
Range:	
Saturation: ($\%Sp0_2$)	1%-100%
Pulse Rate (bpm):	25-240
Perfusion:	0.02%-20%
Accuracy	
Saturation ($\%Sp0_2$)- During no motion conditions[1]	
Adults, Pediatrics	70%-100% ±2 digits 0%-69% unspecified
Neonates	70%-100% ±3 digits 0%-69% unspecified
Saturation ($\%Sp0_2$)- During motion conditions[2,3]	
Adults, Pediatrics[2]	70%-100% ±3 digits 0%-69% unspecified
Neonates[3]	70%-100% ±3 digits 0%-69% unspecified
Pulse Rate (bpm)- During no motion conditions[1]	
Adults, Pediatrics, Neonates	25 to 240 ±3 digits
Pulse Rate (bpm)- During motion conditions[2,3]	
Adults, Pediatrics, Neonates	25 to 240 ±5 digits

Table 13-2. Operating Mode Specifications (Continued)	
Maternal Pulse Oximetry Mode (Masimo)	
Resolution	
Saturation(%$Sp0_2$)	1%
Pulse Rate (bpm)	1
Low Perfusion Performance[4]	
>0.02% Pulse Amplitude and % Transmission > 5%	Saturation (%$Sp0_2$) ±2 digits Pulse Rate ±3 digits

Interfering Substances

Carboxyhemoglobin may erroneously increase readings. The level of increase is approximately equal to the amount of carboxyhemoglobin present. Dyes, or any substance containing dyes, that change usual arterial pigmentation may cause erroneous readings.

[1] *The Masimo SET® SpO_2 parameter with LNOP-Adt sensors has been validated for no motion accuracy in human blood studies on healthy adult volunteers in induced hypoxia studies in the range of 70-100% SpO2 against a laboratory co-oximeter and ECG monitor. This variation equals plus or minus one standard deviation. Plus or minus one standard deviation encompasses 68% of the population.*

[2] *The Masimo SET® SpO_2 parameter with LNOP-Adt sensors has been validated for motion accuracy in human blood studies on healthy adult volunteers in induced hypoxia studies while performing rubbing and tapping motions at 2 to 4 Hz at an amplitude of 1 to 2 cm and a non repetitive motion before 1 to 5 Hz at an amplitude of 2 to 3 cm in induced hypoxia studies in the range of 70-100% SpO2 against a laboratory co-oximeter and ECG monitor. This variation equals plus or minus one standard deviation. Plus or minus one standard deviation encompasses 68% of the population.*

[3] *The Masimo SET® SpO_2 parameter with LNOP-Neo Pt sensors has been validated for neonatal motion accuracy in human blood studies on neonates while moving the neonate's foot at 2 to 4 cm against a laboratory co-oximeter and ECG monitor. This validation equals plus or minus, one standard deviation. Plus or minus one standard deviation encompasses 68% of the population.*

[4] *The Masimo SET® SpO_2 parameter has been validated for low perfusion accuracy in bench top testing against a Biotek Index 2 simulator and Masimo's simulator with signal strengths of greater than 0.02% and a % transmission of greater than 5% for saturations ranging from 70 to 100%. This variation equals plus or minus, one standard deviation. Plus or minus one standard deviation encompasses 68% of the population.*

Maternal Vital Signs History	
Storage/Recall:	8 hours, maximum

Strip Chart Recorder

Table 13-3. Strip Chart Recorder Technical Specifications		
Heart Rate Scale Chart Width: Scaling: Range: Resolution:	**Domestic** 7 cm 30 BPM/cm 30–240 BPM 1 BPM	**International** 8 cm 20 BPM/cm 50–210 BPM 1 BPM
Fetal Pulse Oximetry %FSpO$_2$ Scale Chart Width: Scaling: Range: Resolution:	Domestic 4 cm 10 %/cm or 25%/cm 0–100% 1 %	International 4 cm 12.5 %/cm or 25%/cm 0–100% 1 %
Uterine Activity Scale Chart Width: Scaling: Range: Resolution:	Strain Gauge 4 cm 25 mmHg/cm 0–100 mmHg 1 mmHg	Tocotransducer 4 cm 25 relative units/cm 0–100 relative units 1 relative unit
Maternal Pulse Oximetry %MSpO$_2$ Scale Chart Width: Scaling: Range: Resolution:	**Domestic** 4 cm 10 %/cm or 25%/cm 60–100 % or 0–100 % 1 %	**International** 4 cm 12.5 %/cm or 25%/cm 50–100 % or 0–100 % 1 %
Recorder Drive Speeds: Speed Accuracy:	 1, 2, and 3 cm/min ±1 %	

NOTE: Specifications subject to change without notice.

Chapter 14

Replacement Parts

This section of the manual provides parts lists for the 120 Monitor. Parts lists should be used in conjunction with the other chapters of this manual.

GE makes every effort possible to provide the most up-to-date reference documentation for your equipment. However, in special cases involving field-installed upgrades, the revision level of a diagram or parts list in this manual may not reflect the revision level of your unit's subassemblies. When discrepancies are found, contact your GE Medical Systems *Information Technologies* Service Representative.

Fab drawings are not contained in this manual.

IMPORTANT

FRUs—Major sub-assemblies are usually configured as FRUs (field replacement units) and are offered for customer purchase. Most transducers are considered "consumable"; however, some may be available as repair exchange items through the factory service department.

Replacement Parts Table

Table 14-1. Replacement Parts	
Name	FRU or Part No.
UA/FECG Board	11867E
FECG/MECG adapter (for cables with round plugs)	1442AA0
Front End Motherboard	13542A
Oximeter Carrier Board	13551A
$MSpO_2$ Front Panel Connector Board	13690A
MECG Board	13691A
MECG Option Upgrade Kit.	1211AAO
Paper Orientation Sensor Board	14091A
NBP Final Assembly with DINAMAP Technology	14582G (replaces CAS and Marquette Technology Boards)
Nautilus Ultrasound Transducer Final Assembly	5700 Series
Dual Ultrasound Board	14806B
Nautilus Tocotransducer Final Assembly	2264 Series
DSP (Digital Signal Processing) / Front Panel Interface Board	2001903-001
*Interconnect Cable for Part #11888	13076A
*Spacer Display Frame for Part #11888	14237AA
Recorder LED Board	2002570-002
Isolated Power Supply Board	2003035-001 (replaces earlier 13544 Boards)
Recorder Board	2003039-001 (replaces earlier 14085 Boards)
Power Supply	2005845-001 (replaces earlier 13836 Boards)
Main Motherboard with Corolan	2000608-003 (replaces earlier 11619 Boards)
Flasher Software Utility Kit	1209AAO
Communications	1559AAO (replaces earlier 13388 Boards)

Table 14-1. Replacement Parts	
Name	FRU or Part No.
Switch Panel Replacement Kit (Note: Parts with the “A” suffix are required for older units.)	15096A 15096B
	15097A 15097B
	15098A 15098B
	15099A 15099B
$MSpO_2$ Board	330037
Cable Assembly, Patient Adapter, Nellcor (from SPO2 sensor to monitor)	2006644-001
Front Bezel Assembly for monitor containing 3.5-inch x 4.5-inch display	2003049-002 2003049-003 (Upgrade Kit)
Recorder Printhead Assembly	11821A
Interface CBL-116/NELCOR PLSO,X-1FT	1424AAO
Interface CBL-116/NELCOR PLSO,X-6FT	1424BAO
Recorder Assembly	2008400-002
Main Board	11619F
Recorder Board	2003039-001
Isolated Power Supply Board	2003035-001
Flasher Software Utility Upgrade for English monitors	1208CAO
Flasher Software Utility Upgrade for non-English monitors	1208DAO
EEPROM Replacement Kit for English monitors	1201LAO
EEPROM Replacement Kit for non-English monitors	1201MAO
Strip Chart Paper	4305AA0/CAO (HR scale of 30-240 BPM)
Strip Chart Paper	4305BAO/DAO (HR scale of 50-210 BPM)
3.5” x 4.5” Display (To replace 3” x 3.75” Display)	2009256-001 (English, with blood pressure) 2009256-002 (English, without blood pressure) 2009256-003 (multi-language, with blood pressure) 2009256-004 (multi-language, without blood pressure)
Interconnect Cable for 3.5” x 4.5” Display	2003050-002
3 1/2” Foam Shield	2002881-001
5 1/2” Foam Shield	2002882-001

Table 14-1. Replacement Parts	
Name	FRU or Part No.
Tocotransducer Cable Plug: Trimline, 2260 Series Nautilus, 2264 Series	6158J
MECG Cable Plug	6158F
FECG Cable/Legplate Plug	
Optional Communications Upgrade Kit	1559BAO
BP/MSp0$_2$, Upgrade Kit	1212BAO Model 126 (monitor which requires the Oximeter Carrier Board to support FSpO2)
FSpO$_2$, Upgrade Kit	1212AAO Models 128/129 (monitors which have the Oximeter Carrier Board)
Upgrade Kit (Nellcor), NBP/MSpO$_2$, English monitors with a 3-inch x 3.75-inch display	1210AAO
Upgrade Kit (Nellcor), NBP/MSpO$_2$, non-English monitors with a 3-inch x 3.75-inch display	1210BAO
Upgrade Kit (Nellcor), NBP/MSpO$_2$, English monitors with a 3.5-inch x 4.5-inch display	1210CAO
Upgrade Kit (Nellcor), NBP/MSpO$_2$, non-English monitors with a 3.5-inch x 4.5-inch display	1210DAO
Upgrade Kit (Masimo)	2017259-001 Contact GE Service. Monitor must be shipped to depot repair to upgrade.
Oximeter Carrier Board (Masimo)	2007055-001
Masimo module	2007964-001
Front panel connector (Masimo)	2007253-001
Masimo SET front Panel label	2009579-001
Internal cable (Masimo)	2008958-001
Upgrade Kit, MECG	1211AAO
3.5-inch x 4.5-inch Display Upgrade, English monitors	2009256-001
3.5-inch x 4.5-inch Display Upgrade, English monitors	2009256-002

Table 14-1. Replacement Parts	
Name	FRU or Part No.
3.5-inch x 4.5-inch Display Upgrade, non-English monitors	2009256-003
3.5-inch x 4.5-inch Display Upgrade, non-English monitors	2009256-004
Fetal Movement Detection, English monitors	1202AAO
Fetal Movement Detection, non-English monitors	1202BAO
Assembly Leakage Cable, 120 Series	2009726-001

NOTE: Part Numbers are subject to change. When ordering parts, ask for the latest revision for your monitor.

Calibration Parts

Trimline Tocotransducer Calibration

Table 14-2. Trimline Tocotransducer Calibration	
Part Description	Order Number
52.5 gram weight	13131AA1
Sealing tape	11043AA

CMR Jack Components

Table 14-3. CMR Jack Components	
Part Description	Order Number
Pressure Connector	6158J
475 Ω, 1/8 W, 1% Resistor	472127

Nautilus Tocotransducer

Nautilus Transducer Type and Cat. No. (REF)	Kit Cat. No. (REF)
Calibration - Loop-Style Tocotransducer, 2264 DAX/EAX/FAX/ KAX/LAX/MAX	2003663-001
Calibration - Button-Style Tocotransducer, 2264 AAX/BAX/CAX/ GAX/HAX/JAX	2003664-001
Top Cover - Loop-Style Ultrasound Transducer, 5700 KAX/LAX/MAX	2011679-001
Top Cover - Button-Style Ultrasound Transducer, 5700GAX/HAX/JAX	2011680-001

Chapter 15

Troubleshooting

This section of the manual provides a troubleshooting guide for the most basic 120 Series Monitor operational problems. If the response to a specific question is not found, contact the Service Department at one of the following numbers:

Inside the United States: 1-800-558-5120.

Outside the United States: 1-414-355-5000;
or contact your local distributor.

This section contains the following:

General Troubleshooting 15-2
Ultrasound Troubleshooting. 15-3
FECG Troubleshooting 15-4
Fetal Pulse Oximetry Troubleshooting 15-5
External Uterine Activity Troubleshooting 15-8
Internal UA Troubleshooting 15-9
MECG Troubleshooting. 15-10
Blood Pressure Troubleshooting 15-11
Maternal Pulse Oximetry Troubleshooting 15-12

General Troubleshooting

Table 15-1. General Troubleshooting

Problem	Probable Cause	Possible Solution
No monitoring functions and green Power indicator does not illuminate when Power switch is placed in the On (I) position.	■ Monitor is not connected to an AC line receptacle. ■ The AC power cord is defective. ■ The AC outlet is defective. ■ The power cord is not connected to the monitor. ■ Blown fuses.	■ Connect the power cord to an AC line receptacle. ■ Replace the power cord. ■ Use a different outlet. ■ Connect the power cord to the monitor. ■ Call Biomedical Engineering Department.
■ Recorder does not function and the Record indicator is off. ■ Recorder does not function and the Record indicator flickers three short flashes every five seconds. ■ Recorder functions however, Record indicator flashes on and off every second. ■ Recorder does not function; the Record indicator is off; the message PAPER INCORRECTLY LOADED, RELOAD WITH BLACK SQUARES DOWN is shown in maternal waveform area. ■ Recorder does not function and the Record indicator is on.	■ Recorder is off, out of paper, or paper is incorrectly loaded. ■ Recorder is in maternal-only mode. ■ Paper supply is low. ■ Paper loaded backwards. ■ Service required.	■ Press Record pushbutton; or install/re-install paper (see “Loading Strip Chart Recorder Paper” on page 5-2), then press Record button. ■ Press Record pushbutton to turn on. ■ Install paper. ■ Re-install paper. ■ Call Biomedical Engineering Department.
Incorrect time and date.	■ Time incorrectly set. ■ Clock circuit or battery fault.	■ Access the General Setup screen and reset the time and date. ■ Call Biomedical Engineering Department.
No heartbeat or pulse sounds.	■ Volume set too low. ■ Transducer not connected or is loose.	■ Press the Volume △ pushbuttons or access the respective setup screen(s) (FECG, US, or US2) to increase the volume. ■ Ensure that each transducer is securely attached to monitor and applied to the patient.

Ultrasound Troubleshooting

Table 15-2. Ultrasound Troubleshooting

Problem	Probable Cause	Possible Solution
Ultrasound not functioning properly.	■ Transducer not properly connected to monitor. ■ Transducer placement. ■ Too little gel applied to transducer. ■ Defective transducer. ■ Active fetus or mother. Fetal arrhythmia or hiccups. Extreme maternal obesity. ■ No signal. ■ Service required.	■ Ensure that transducer is securely attached to monitor. ■ Wait before moving transducer; FHR often returns. Reposition transducer. ■ Apply more gel. ■ Replace transducer. ■ Use alternate technique. ■ Auscultate FHR. ■ Call Biomedical Engineering Department.
Static noise on ultrasound.	■ Active fetus. ■ Environmental noise. ■ Maternal movement. ■ Defective transducer.	■ Reposition transducer. ■ Keep sheets and gown off transducer. Do not hold transducer with hand. ■ Use alternate monitoring mode. ■ Replace transducer.
Rate on FHR area of display and FHR trend on strip chart paper do not correlate.	Monitor is set for 30 BPM/cm vertical scale and 20 BPM/cm vertical scale strip chart recorder paper is being used (or vice versa).	Call Biomedical Engineering Department.

FECG Troubleshooting

Table 15-3. FECG Troubleshooting

Problem	Probable Cause	Possible Solution
Internal FECG erratic or not recording properly.	■ Transducer not properly connected to monitor. ■ Attachment pad or legplate not securely attached to patient. ■ Electrode wire not secure in legplate post. ■ Paste is dried or incorrect paste is being used. ■ Electrode not properly attached. ■ No FECG signal. ■ Defective electrode. ■ Defective attachment pad. ■ Service required.	■ Ensure transducer is securely attached to the monitor. ■ Secure attachment pad or legplate to patient. ■ Inspect legplate connection. ■ Check ECG paste; re-apply, if necessary. ■ Replace electrode. ■ Auscultate FHR. ■ Replace electrode. ■ Replace attachment pad. ■ Call Biomedical Engineering Department.
Rate in FHR area of the display and the FHR trend on the strip chart paper do not correlate.	Monitor is set for 30 BPM/cm vertical scale and 20 BPM/cm vertical scale strip chart recorder paper is being used (or vice versa).	Call Biomedical Engineering Department.

Fetal Pulse Oximetry Troubleshooting

Table 15-4. Fetal Pulse Oximetry Troubleshooting

Problem	Probable Cause	Possible Solution
Displayed $FSpO_2$ does not correlate with the SaO_2 value calculated from a fetal scalp blood sample measurement on a blood gas analyzer.	■ Close correlation requires simultaneous blood sampling and pulse oximeter measurements from the same *arterial* supply. Blood samples exposed to air during the sampling process may not accurately reflect true arterial values.	
	■ The SaO_2 calculation may not have been correctly adjusted for the effects of pH, temperature, $PaCO_2$, 2,3-DPG, or the presence of fetal hemoglobin. In general, calculated SaO_2 values are not as reliable as direct CO-Oximeter or pulse oximeter measurements.	■ Check whether calculations have been corrected appropriately for relevant variables. Refer to the equation in "Principles of Operation" on page 6-6 of the Corometrics 120 V3.5 Series Operator's Manual for more information.)
	■ 120 F-Series accuracy can be affected by incorrect sensor application or use, significant levels of dysfunctional hemoglobins, excessive patient movement, venous pulsation, or nearby electrosurgical interference.	■ Observe all instructions, warnings, and cautions in this manual and in the 120 Series Operator's Manual.
	■ Oxygen saturation greater than 85% and/or pulse rate less than 100 could indicate that the values are maternal in origin.	■ Check sensor placement to ensure that it is properly positioned on the fetus
Displayed $FSpO_2$ does not correlate with the SaO_2 value calculated from a fetal scalp blood sample measurement on a laboratory CO-Oximeter.	■ Close correlation requires simultaneous blood sampling and pulse oximeter measurements from the same *arterial* supply. Blood samples exposed to air during the sampling process may not accurately reflect true arterial values.	
	■ Fractional measurements may not have been converted to functional measurements before the comparison was made. The 120 F-Series Monitor, as well as other two-wavelength oximeters, measures functional saturation. Multi-wavelength oximeters measure fractional saturation. Fractional measurements must be converted to functional measurements for comparison.	■ Refer to the equation in "Principles of Operation" on page 6-6 of the Corometrics 120 V3.5 Series Operator's Manual for this conversion.
	■ Oxygen saturation values greater than 85% could indicate that the values are maternal in origin.	■ Check sensor placement to ensure that it is properly positioned on the fetus.

Table 15-4. Fetal Pulse Oximetry Troubleshooting (Continued)

Problem	Probable Cause	Possible Solution
$FSpO_2$ values change rapidly; Pulse Amplitude indicator is erratic.	■ Fetal distress.	■ Check the fetus for other signs of distress.
	■ Excessive maternal or fetal patient motion may be making it impossible for the monitor to find a pulse pattern.	■ If possible, keep the patient still.
	■ Improperly applied sensor.	■ Check whether the sensor is positioned properly, and reposition it if necessary.
	■ SLOW mode selected.	■ Access $FSpO_2$ Setup screen and select FAST mode.
	■ A nearby electrosurgical unit (ESU) may be interfering with performance.	■ Check for interference from other hospital devices. Do not use the 120 Series Monitor in the presence of an ESU.
$FSpO_2$ readings greater than 85%.	■ The sensor may be facing the uterine wall and may be reading maternal saturation.	■ Confirm that the sensor is positioned properly against the fetus.
	■ The sensor may be affected by maternal pulsations.	■ Ensure that the displayed $FSpO_2$ is fetal and not maternal.
Patient module cannot be connected.	■ Invalid fetal patient module.	■ Use only a Corometrics Fetal Patient Module.
	■ Damaged fetal patient module.	■ Check for bent connector pins. Replace with another Corometrics Fetal Patient Module.
Pulse Search icon is displayed; Pulse Amplitude appears to indicate pulses, but there is no $FSpO_2$ reading displayed	■ Fetal distress.	■ Check the fetus for other signs of distress.
	■ The signal quality is below the acceptable threshold requirement necessary to post data on the display.	
	■ Excessive maternal or fetal patient motion may be interfering with signal quality.	■ If possible, keep the patient still.
	■ The sensor may be improperly positioned.	■ Assess sensor location and determine appropriate adjustment.
	■ The fetus's perfusion may be too low for the monitor to detect an acceptable pulse.	
	■ If *Searching* indicator continues to display after evaluations and adjustments: the sensor may be damaged; or the patient module may be damaged.	■ Replace the sensor; or try another Corometrics Fetal Patient Module.

Table 15-4. Fetal Pulse Oximetry Troubleshooting (Continued)

Problem	Probable Cause	Possible Solution
Sensor Lifted icon displayed in $FSpO_2$ area of display.	■ Sensor not making adequate contact at the sensor site on the fetus. ■ Damaged sensor.	■ Assess sensor position relative to fetal head. Assess sensor depth relative to the fetal presenting part; advance or withdraw the sensor as indicated in "FSpO2 Status Icons" on page 5-20. ■ If the icon does not respond to advancing or withdrawing the sensor, remove the sensor and place a new sensor, as directed in "FSpO2 Status Icons" on page 5-20.
Sensor Disconnected icon displayed in $FSpO_2$ area of display.	■ Sensor disconnected from fetal patient module cable; or fetal patient module cable disconnected from monitor. ■ Damaged fetal patient module. ■ Invalid $FSpO_2$ sensor connected to fetal patient module cable.	■ Ensure fetal patient module cable is firmly attached to sensor assembly and monitor. If connections are OK, use a new sensor. ■ Replace with another Corometrics Fetal Patient Module. ■ Replace with valid Nellcor OxiFirst Fetal Oxygen Sensor (Series FS14).
COMM message shown in $FSpO_2$ area of display.	■ Communication error between the built-in $FSpO_2$ module and the remainder of the monitor circuitry.	■ Contact Biomedical Engineering Department.
FHR slows during, or immediately after, sensor placement.	■ Changes in intracranial pressure due to examination could cause a reflex bradycardia stimulus.	■ Stop the exam. Do not proceed with sensor placement. Wait for the FHR to return to the previous range.
Dashes (– – –) shown in $FSpO_2$ display area.	■ Monitor unable to make a determination due to insufficient signal. ■ Improperly applied sensor. ■ Excessive fetal movement. ■ Excessive maternal movement. ■ Maternal uterine contraction. ■ Damaged sensor. ■ SLOW mode selected.	■ Check centimeter mark on stylet chamber relative to the introitus. The sensor may have ascended or descended independent of fetal head descent. ■ Ensure that the fetal patient module cable is firmly attached to the monitor and to the sensor assembly. ■ Move sensor to another location. ■ Wait for movement to stop. ■ Restrict patient movement. ■ Wait for contraction to end. ■ Replace sensor. ■ Access $FSpO_2$ Setup screen and select FAST mode.
REPAIR message shown in $FSpO_2$ display area.	■ System error or self-test failure.	■ Contact Biomedical Engineering Department.

External Uterine Activity Troubleshooting

Table 15-5. External UA Troubleshooting

Problem	Probable Cause	Possible Solution
Tocotransducer not recording contractions.	■ Transducer not properly connected to monitor. ■ Transducer not properly placed. ■ Transducer not secured to patient. ■ Defective transducer/cable assembly. ■ No maternal contractions. ■ UA Reference range exceeded.	■ Ensure that transducer is securely attached to monitor. ■ Reposition transducer. ■ Secure or re-apply transducer to patient. ■ Replace transducer/cable assembly. ■ Wait. ■ Loosen belts or remove transducer from patient. Press UA Reference pushbutton while no pressure is applied to transducer button. Re-apply transducer. Do not overtighten belt. Press UA Reference pushbutton again between contractions.
Flashing “+” sign.	Relative pressure > 100.	Press the UA Reference pushbutton between contractions.
CHECK TOCO message is shown in UA area of the display area when the UA Reference pushbutton is pressed.	■ UA Reference pushbutton pressed before UA circuits stabilized. ■ UA Reference range exceeded due to over-tightening belt. ■ Transducer defective. ■ Service required.	■ You must wait ten seconds following powering on the monitor and/or connecting to the UA connector. ■ Loosen belts or remove transducer from patient. Press UA Reference pushbutton while no pressure is applied to transducer button. Re-apply transducer. Do not overtighten belt. Press UA Reference pushbutton again between contractions. ■ Replace transducer. ■ Call Biomedical Engineering Department.

Internal UA Troubleshooting

Table 15-6. Internal UA Troubleshooting

Problem	Probable Cause	Possible Solution
Internal pressure not measuring correctly.	■ Transducer not properly connected to monitor. ■ Air bubble in dome; or catheter blocked. ■ Dome is cracked. ■ Strain gauge not at same height as catheter tip. ■ Catheter has fallen out of place. ■ Catheter or strain gauge not zeroed. ■ Service required.	■ Ensure transducer is securely attached to monitor. ■ Flush dome and catheter. ■ Replace dome. ■ Adjust strain gauge height. ■ Replace catheter. ■ Calibrate catheter or strain gauge. ■ Call Biomedical Engineering Department.
CHECK IUP message displayed in UA area of the display.	■ Blockage in fluid-filled catheter. ■ Fetus pressing directly on catheter. ■ Defective strain gauge or catheter. ■ Service required.	■ Flush catheter. Re-zero. Replace catheter if necessary. ■ Reposition by twisting catheter. ■ Replace strain gauge or catheter. ■ Call Biomedical Engineering Department.

MECG Troubleshooting

Table 15-7. MECG Troubleshooting

PROBLEM	PROBABLE CAUSE	POSSIBLE SOLUTION
MECG erratic or not functioning properly.	■ Transducer not properly connected to monitor. ■ Electrodes not properly placed. ■ Clips not attached to electrodes properly. ■ Electrode gel dried. ■ Defective MECG cable. ■ Service required. ■ Selected lead providing inadequate signal.	■ Ensure transducer is securely attached to monitor. ■ Re-apply electrodes. ■ Check clip attachments. ■ Check electrodes and re-apply gel if necessary. ■ Replace cable. ■ Call Biomedical Engineering Department. ■ Change lead selection on MHR/P Setup screen.
Dashes (– – –) shown in MHR/P area of display.	Monitor unable to make a determination due to insufficient signal.	Ensure patient is not asystolic. Ensure electrodes are firmly secured to patient.

Blood Pressure Troubleshooting

Table 15-8. Blood Pressure Troubleshooting

Problem	Probable Cause	Possible Solution
High reading.	Measurement taken during uterine contraction.	■ Annotate chart, then take a manual reading in-between contractions. ■ If possible, cancel reading during contraction. ■ Enable the monitor's Smart BP feature.
CHECK CUFF message displayed in NBP area of display.	■ Improper cuff position. ■ Loose cuff. ■ Air pressure error. ■ Maternal movement. ■ Hose not properly connected to monitor. ■ Neonatal cuff connected.	■ Reposition cuff. ■ Tighten cuff. ■ Contact Biomedical Engineering Department. ■ Restrict patient limb movement. ■ Ensure that hose is firmly attached to monitor. ■ Ensure an adult cuff is connected.
OVERPRESSURE message displayed in NBP area of display.	■ Cuff pressure has exceeded the overpressure limit of 285 ± 15 mmHg. ■ Kinked hose. ■ Blocked hose.	■ Restrict patient limb movement. If this is not the case, contact Biomedical Engineering Department. ■ Check the external cuff for kinks. ■ Perform pneumatic test.
LEAK message displayed in NBP area of display.	Pneumatic leak; air leak; or loose cuff.	Check cuff for snug fit. Check cuff and hose connections for leaks.
COMM message displayed in NBP area of display.	Communication error between the built-in NBP module and the remainder of the monitor circuitry.	Call Biomedical Engineering Department.
MOTION message displayed in NBP area of display.	Excessive maternal movement.	Restrict patient limb movement. Restrain limb if necessary.
Dashes (– – –) displayed in NBP area of display (and possibly in MHR/P area if NBP selected as MHR/P source).	Maximum reading determination time exceeded.	■ Reposition cuff. ■ Check patient for arrhythmia. Move cuff to another limb.
REPAIR message display in NBP area of display.	System error or self-test failure.	Contact Biomedical Engineering Department.
WEAK SIGNAL message	Monitor unable to make a determination due to insufficient signal.	Assess patient situation.
MOTION message	Excessive maternal movement.	Talk to patient about the importance of minimizing limb movement.

Maternal Pulse Oximetry Troubleshooting

Table 15-9. Maternal Pulse Oximetry Troubleshooting

Problem	Probable Cause	Possible Solution
COMM message shown in $MSpO_2$ area of display.	Communication error between the built-in $MSpO_2$ module and the remainder of the monitor circuitry.	Contact Biomedical Engineering Department.
Dashes (– – –) shown in %$MSpO_2$ display area.	■ Monitor unable to make a determination due to insufficient signal.	■ Check patient. The patient may be experiencing shock, hypotension, severe vasoconstriction, severe anemia, hypothermia, arterial occlusion proximal to the sensor, or cardiac arrest. Ensure that the intermediate cable is firmly attached to the monitor and to the sensor assembly.
	■ Improperly applied sensor.	■ Ensure sensor is not too tight. Move sensor to another location.
	■ Excessive maternal movement.	■ Restrict patient limb movement. Restrain limb if necessary.
	■ Excessive ambient light.	■ Cover sensor with opaque material.
	■ Damaged sensor	■ Replace sensor.
MHR/P Pulse source is blank when $MSp0_2$ is selected	SLOW mode selected	Select NORMAL or FAST mode on $MSp0_2$ setup screen.
REPAIR message shown in $MSpO_2$ area of display.	System error or self-test failure.	Contact Biomedical Engineering Department.

Appendix A

Factory Defaults

Factory Defaults are found in the table that follows.

Table of Defaults

Table A-1. Summary of Factory Defaults				
Setup Screen	Field Description	Factory Default	Default Options	Hospital Preference
FECG or US/US2	HR Offset (Applies to US or US2—whichever is FHR2)	Off	On, Off, 10 minutes	
	FHR Volume	5	0-9	
	FHR Alarm Limits	High Low 160 120 BPM	200-140, Off 60-140, Off	
	Audio Alarms	On	On, Off	
	Volume	5	1-9	
$FSp0_2$	Response Time (Averaging Mode)	Slow	Slow, Fast	
	Print Interval	5 min	Off, 2, 5, 10, 15, 30, 60 min	
	% 0_2 Trace	On	On, Off	
NBP	Display	On	On, 1, 2, 3, 5, 10, 15, 30 min	
	Mode	Manual	Manual, Auto, 1, 2, 3, 4, 5, 10, 15, 20, 30, 40, 45, 60, 90, 120 min	
	NBP Reading Done	5	0-9	
	Alarm Systolic Diastolic MAP MHR/P	High Low 160 90 mmHg 90 50 mmHg 140 50 mmHg 120 50 BPM	High Low 70-240, Off 50-150, Off 70-130, Off 30-120, Off 70-150, Off 30-120, Off 100-250, Off 35-120, Off	
	Audio Alarm	On	On, Off	
	Volume	5	1-9	

Table A-1. Summary of Factory Defaults				
Setup Screen	Field Description	Factory Default	Default Options	Hospital Preference
$MSpO_2$	Response Time (Nellcor)	Normal	Slow, Normal, Fast	
	Averaging Time (Masimo)	8 seconds	2, 4, 8, 10, 12, 14, 16 seconds	
	Sensitivity (Masimo)	Normal	Normal, Maximum	
	Print Interval	5 minutes	Off, 2, 5, 10, 15, 30, 60 minutes	
	$\%O_2$ Trace	Off	On, Off	
	Alarms $MSpO_2$ MHR/P	High Low 100 95% 120 50 BPM	High Low 85-100, Off 80-99, Off 100-250, Off 35-120, Off	
	Audio Alarms	On	On, Off	
	Volume	5	1-9	
MHR/P	Source	Auto	Auto, MECG, $MSp0_2$, NBP	
	MHR/P Trace	Off	On, Off	
	Volume	5	0-9	
	Alarms	High Low 120 50 BPM	High Low 100-250 35-120	
	Audio Alarms	On	On, Off	
	Alarm Volume	5	1-9	
	MECG Lead	II	I, II, III	
	Pacer	Off	On, Off	
Normal Operation	(Waveform Display)	MECG	FECG, MECG, $FSp0_2$, $MSp0_2$, Off	
	(MECG Waveform Size)	1X (1 mV/cm)	.25X, .5X, 1X, 2X, 4X, Auto	

Table A-1. Summary of Factory Defaults				
Setup Screen	Field Description	Factory Default	Default Options	Hospital Preference
Master AlarmSetup	Audio Alarms NBP MHR/P $MSpO_2$	 On On On	 On, Off On, Off On, Off	
	Re-Alarm (MECG and $MSpO_2$ only)	120 sec	30-120 (in 5 second increments)	
	Alarm Limits Systolic Diastolic MAP MHR/P $MSpO_2$	High Low 160 90mmHg 90 50 mmHg 140 50 mmHg 120 50 BPM 100 95%	High Low 70-240, Off 50-150, Off 70-130, Off 30-120, Off 70-150, Off 30-120, Off 100-250, Off 35-120, Off 85-100, Off 80-99, Off	
	Volume	5	1-9	
General	Time/Date	Set to current local date and time.	Set to current local date and time.	
	Play Song	Off	Off, Happy Birthday, Brahm's Lullaby, Rock-a-Bye-Baby, All.	
	Volume	5	0-9	
	SpO_2 Scale	0–100 %	Auto, 0-100% (Does not change)	
	Paper Speed	United States: 3 cm/min International: 1 cm/min	1-3 cm/min	
	Paper Chime	Out Only	Off, Low/out, Out only	
	Volume	5	1-9	
	Light (on recorder)	On	On, Off	
	$MSpO_2$ Print Interval (External Monitor)	5 min	Off, 2, 5, 10, 15, 30, 60 min	
	$FSpO_2$ Print Interval (External Monitor)	5 min	Off, 2, 5, 10, 15, 30, 60 min	
	$FSpO_2$ Trace (External Monitor)	Off	On, Off	
Vital Signs History[a]	HX Interval	Event	1, 5, 10, 15, 30, 60, Event	

Table A-1. Summary of Factory Defaults				
Setup Screen	Field Description	Factory Default	Default Options	Hospital Preference
Install Options (Service)	Default Settings	Factory	Factory, Current, New Hospital, Hospital-wide	
	Line Frequency	United States: 60 Hz International: 50 Hz	50 Hz, 60 Hz	
	ECG Artifact Elimination	Off	On, Off	
	Scaling	United States: 30–240 BPM International: 50–210 BPM	United States: 30–240 BPM International: 50–210 BPM	
	Language	Set according to shipping destination	Set according to shipping destination	
	NBP 1-Minute Interval	On	On, Off	
	HR (Heart Rate) Offset	On with 10-min Auto-Revert	Off, On, 10-min	
	Default TOCO Reference	10 relative units	5, 10, 15, 20, 25 relative units	
	FM (Fetal Movement) Remote Mark	On	On, Off	
	COROLAN Address Checking	Off	On, Off	
	HBC (Heartbeat Coincidence Enable)	On	On, Off	
	VS (Vital Signs) Print Interval	Real Time	Real Time, Chart Style	
	Recorder Font Size	Medium	Small, Medium, Large	
	Fetal Alert/Alarm	Off	Off, Alarms, Alerts	
	Smart BP	On	On, Off	

NOTE: You must cycle power to reset factory defaults.

For your notes

Appendix B

Alarms Summary

A summary of the 120 series alarms is found in the table that follows.

Table of Alarms

Table B-1. Summary of 120 Series Alarms			
Type	Condition	Visible Advisory	Audible Advisory
	Paper Speed	United States: 3 cm/min International: 1 cm/min	1-3 cm/min
FHR	An alarm setting (audio or high/low limit) is turned off. Alarm Defaults Audio: on Volume: 5 Limits: High = 160 BPM, Low = 120 BPM	displays to the left of the FHR mode title.	—
	FHR limit (high or low) actively being violated. or Unsilenced, resolved FHR limit violation (the limit was violated but the FHR has since returned to the normal range before clinical acknowledgement). For continuous limit violations: a high alarm activates after 5 minutes; a low alarm activates after 30 seconds. About Latching Alarms: The FHR limit alarms are latching alarms which means that a clinician must acknowledge the alarm using the monitor's Alarm Silence button in order to clear the alarm.	FHR numeric flashes.	Alternating high/low tones (if audio enabled).
	Inadequate FHR signal quality.	Flashing dashes "– – –" in place of FHR numeric.	Alternating high/low tones (if audio enabled).

Table B-1. Summary of 120 Series Alarms			
Type	Condition	Visible Advisory	Audible Advisory
NBP	An alarm setting (audio or high/low limit) is turned off. Alarm Defaults Audio: on Volume: 5 Systolic Limits: High = 160 mmHg, Low = 90 BPM Diastolic Limits: High = 90 mmHg, Low = 50 mmHg MAP Limits: High = 140 mmHg, Low = 50 mmHg MHR/P Limits: High = 120 BPM, Low = 50 BPM	displays to the left of the NBP mode title.	—
	Systolic, diastolic, or MAP pressure value (high or low) actively being violated.	NBP numeric (systolic, diastolic, or MAP) flashes.	Alternating high/low tones (if audio enabled).
	Malfunction with NBP circuitry, cuff, or air hoses.	CHECK CUFF, LEAK, COMM, MOTION, WEAK SIGNAL, or REPAIR message displays in NBP area.	Alternating high/low tones (if audio enabled).
MHR/P[a]	An alarm setting (audio or high/low limit) is turned off. Alarm Defaults Audio: on Volume: 5 Limits: High = 120 BPM, Low = 50 BPM Re-alarm: 120 sec	displays to the left of the MHR/P mode title.	—
	MHR/P limit (high or low) actively being violated. The tachycardia response time is < 8 seconds.	MHR/P numeric flashes.	Alternating high/low tones (if audio enabled).
	Asystole.	Flashing dashes "– – –" in place of MHR/P numeric.	Alternating high/low tones (if audio enabled).
	MECG leads off.	Flashing dashes "– – –" in place of MHR/P numeric and MECG LEADS OFF message displays underneath.	Alternating high/low tones (if audio enabled).

Table B-1. Summary of 120 Series Alarms			
Type	Condition	Visible Advisory	Audible Advisory
	An alarm setting (audio or high/low limit) is turned off. Alarm Defaults Audio: on Volume: 5 Limits: High = 100%, Low = 95% Re-alarm: 120 sec	displays to the left of the $MSpO_2$ mode title.	—
$MSpO_2$[b]	$\%MSpO_2$ limit (high or low) actively being violated. Issued after about 8 seconds.	$\%MSpO_2$ numeric flashes. $\%MSpO_2$ value and pulse rate print on the strip chart.	Alternating high/low tones (if audio enabled).
	Malfunction with $MSpO_2$ circuitry.	COMM or REPAIR message displays in $MSpO_2$ area.	Alternating high/low tones (if audio enabled).
	$MSpO_2$ intermediate cable disconnected from monitor; sensor assembly disconnected from intermediate cable; or sensor or cable has a broken wire.	Dashes "– – –" in place of $\%MSpO_2$ numeric.	Alternating high/low tones (if audio enabled).

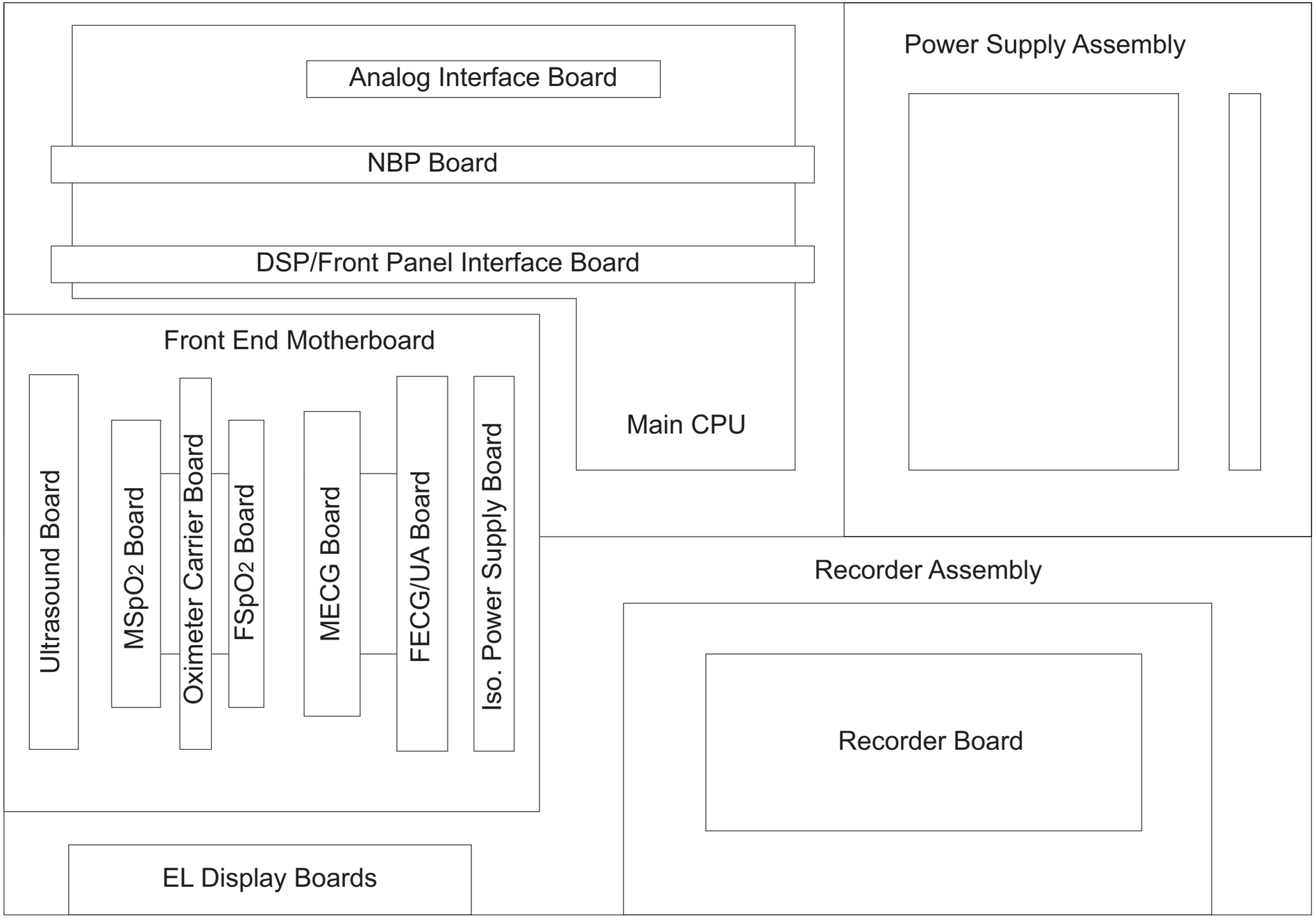
[a] There is an MECG re-alarm.
[b] There is an $MSpO_2$ re-alarm.

NOTE: You must cycle power to reset factory defaults.

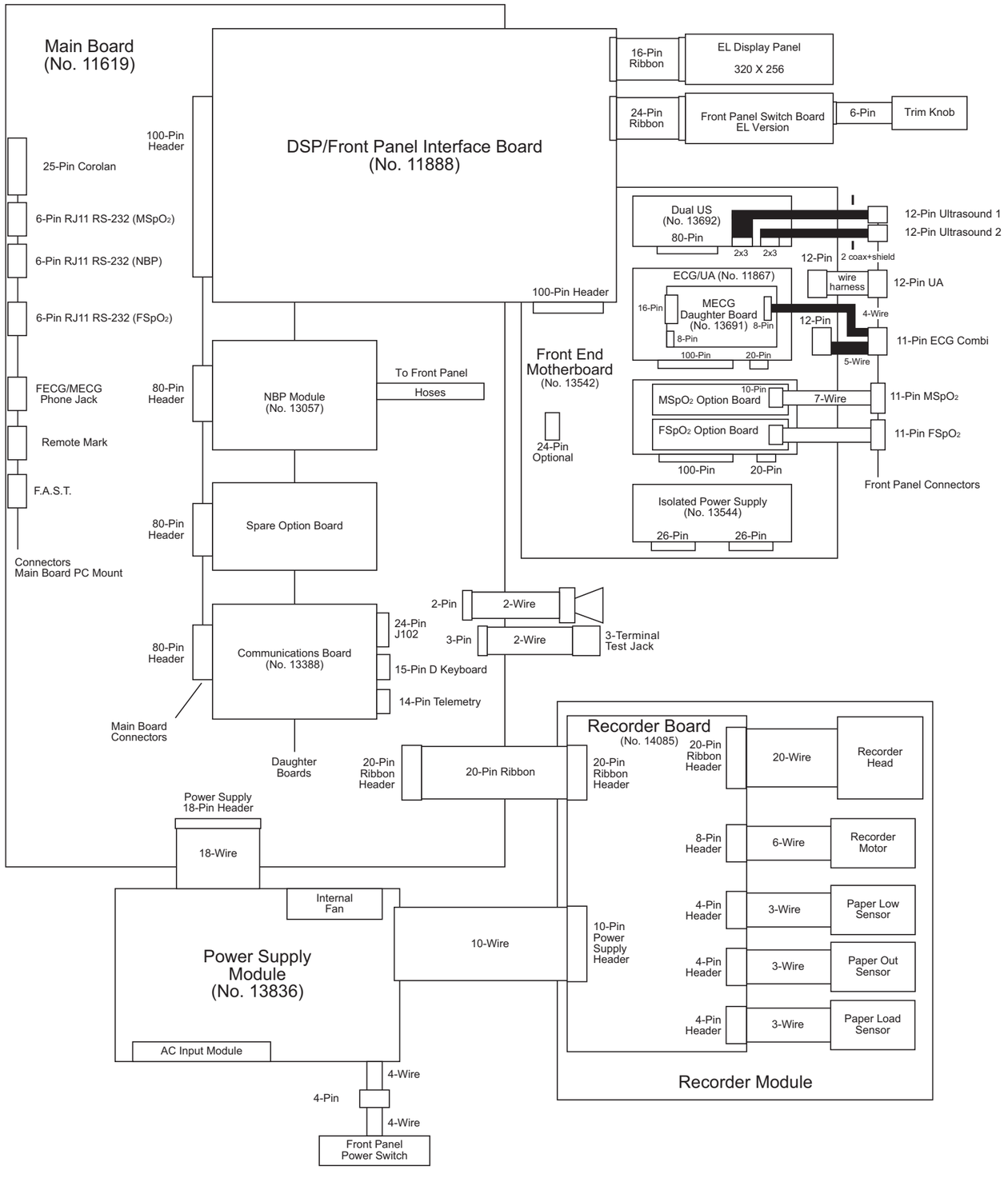
Appendix C

Drawings

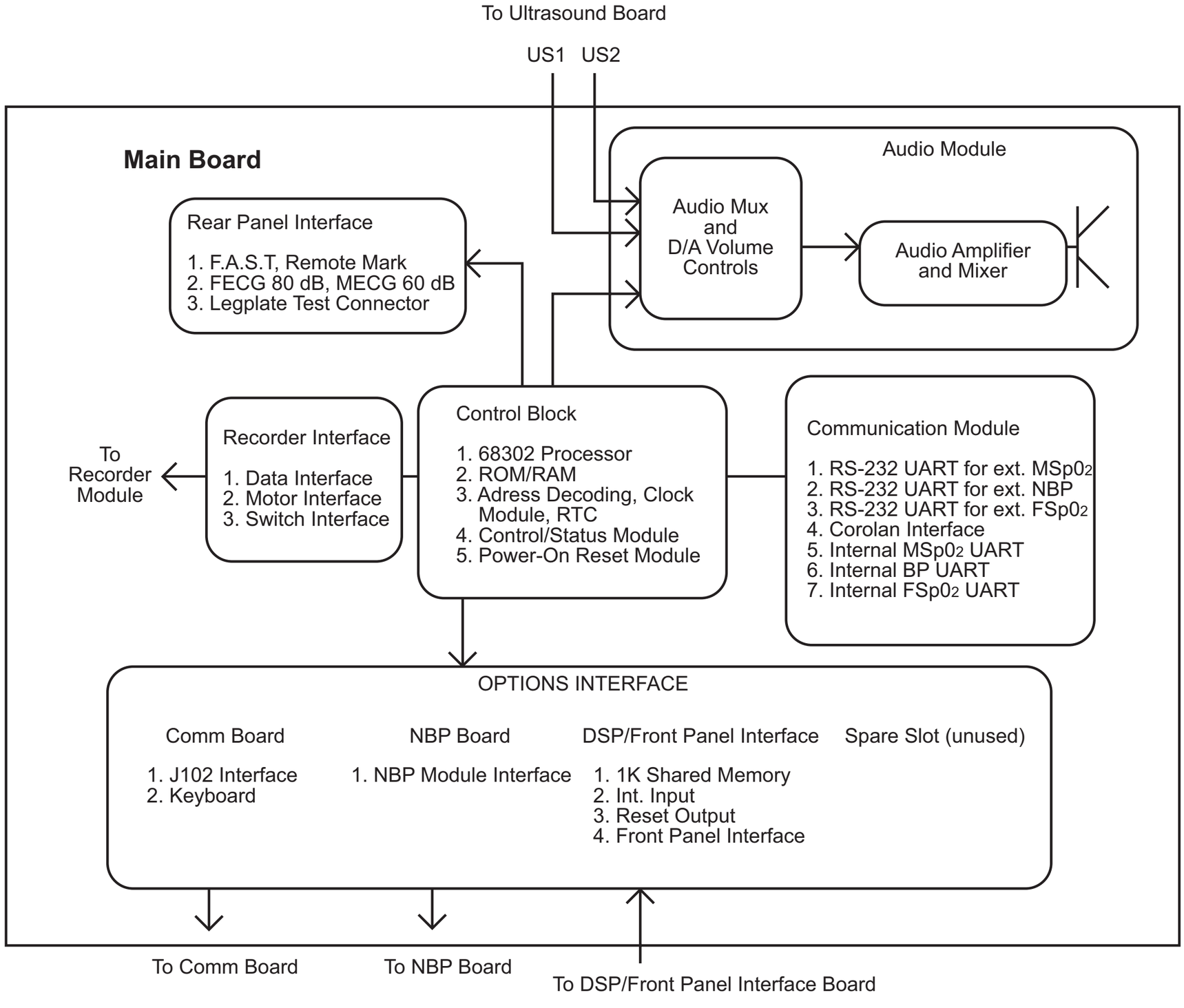
For your notes



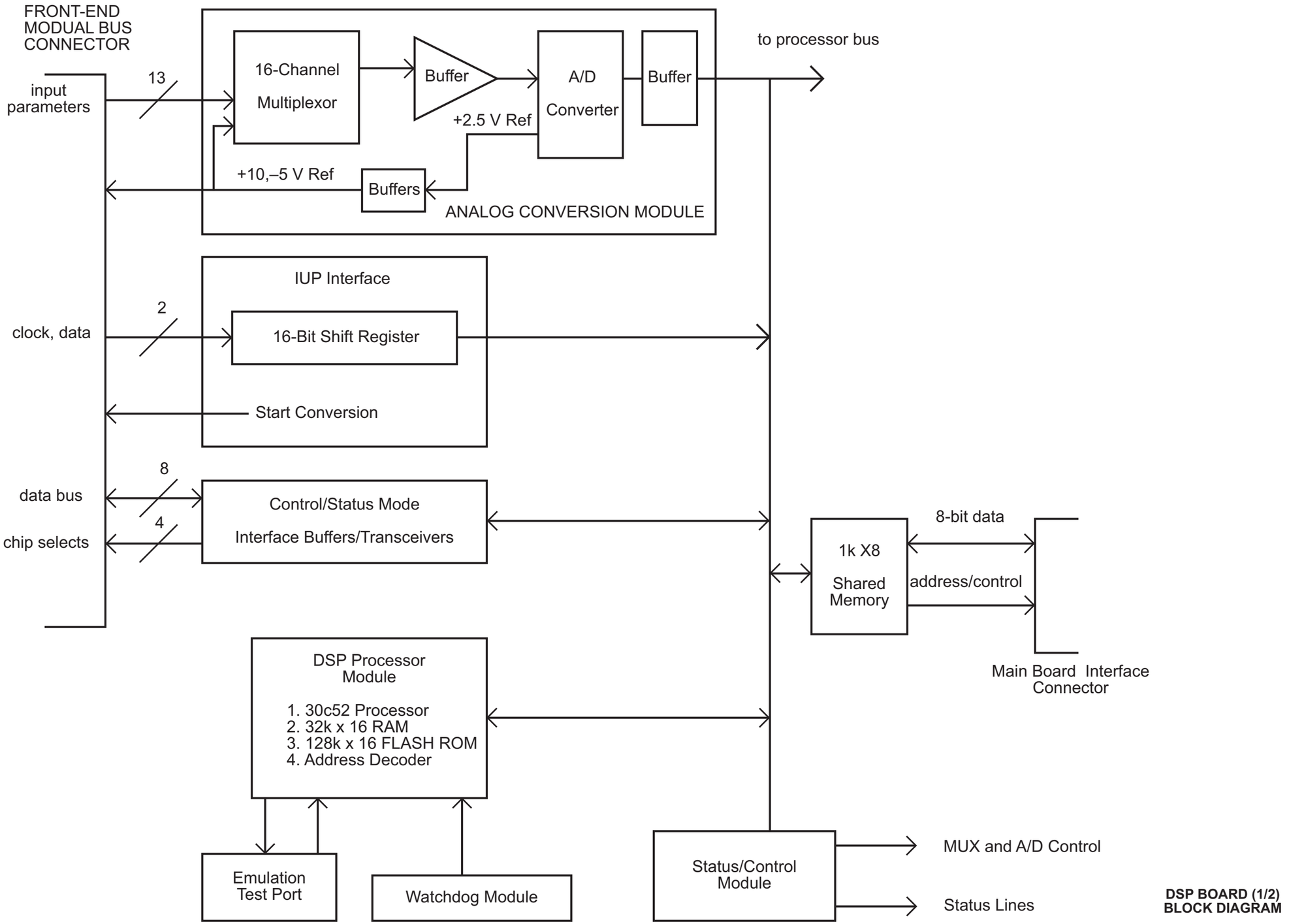
OVERALL LAYOUT (1/2)
BLOCK DIAGRAM



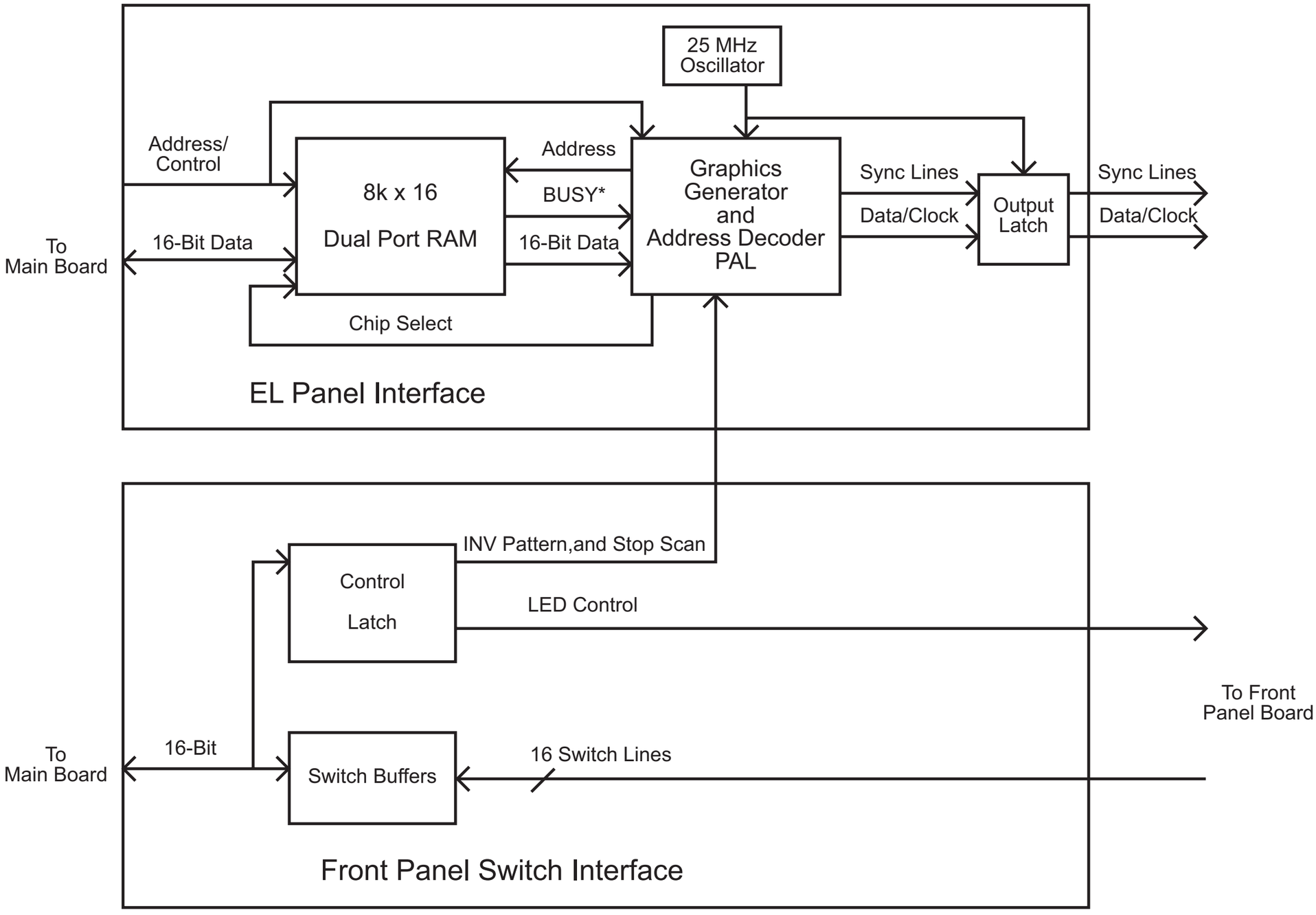
OVERALL LAYOUT (2/2)
BLOCK DIAGRAM



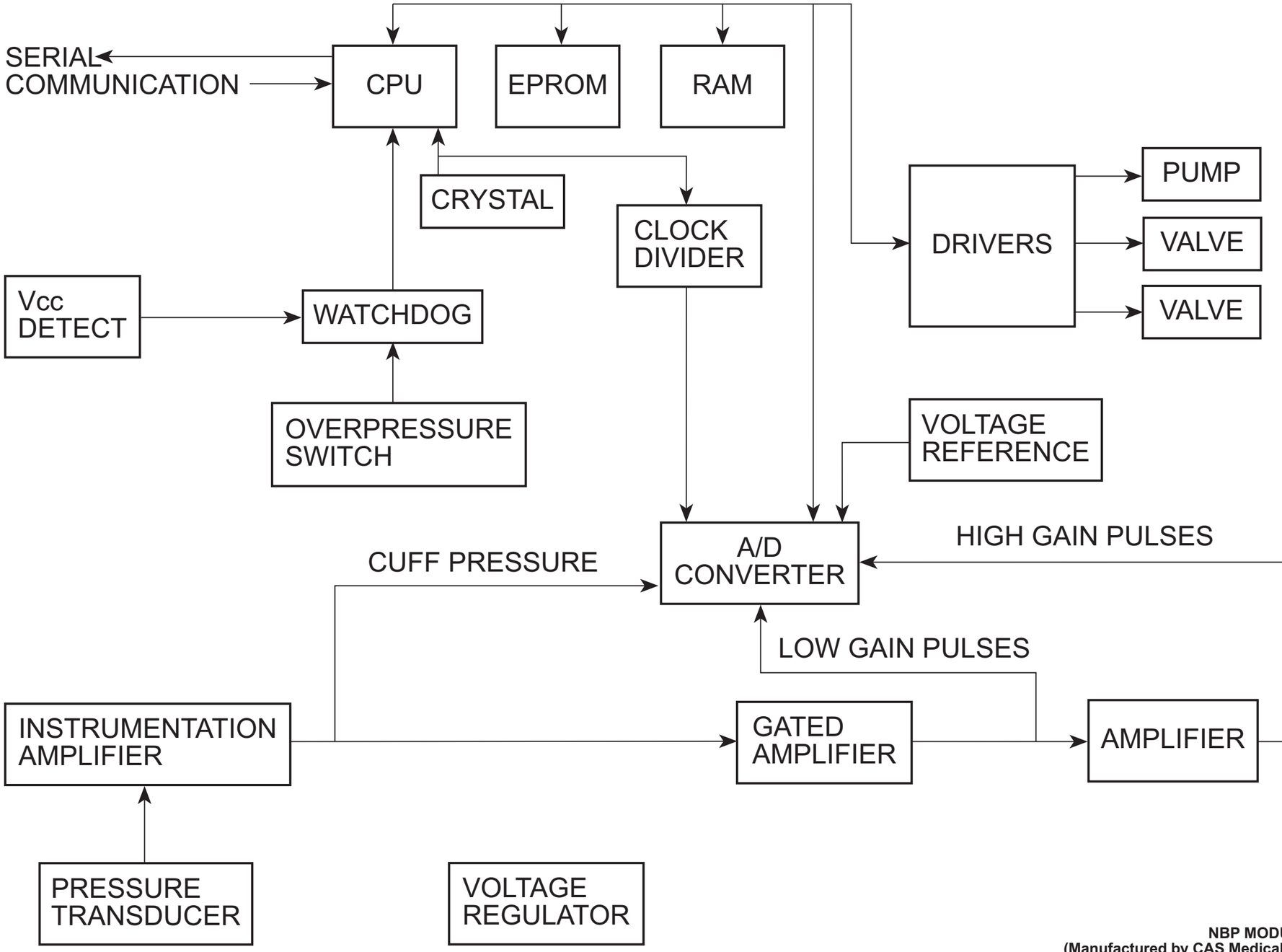
MAIN MOTHERBOARD BLOCK DIAGRAM



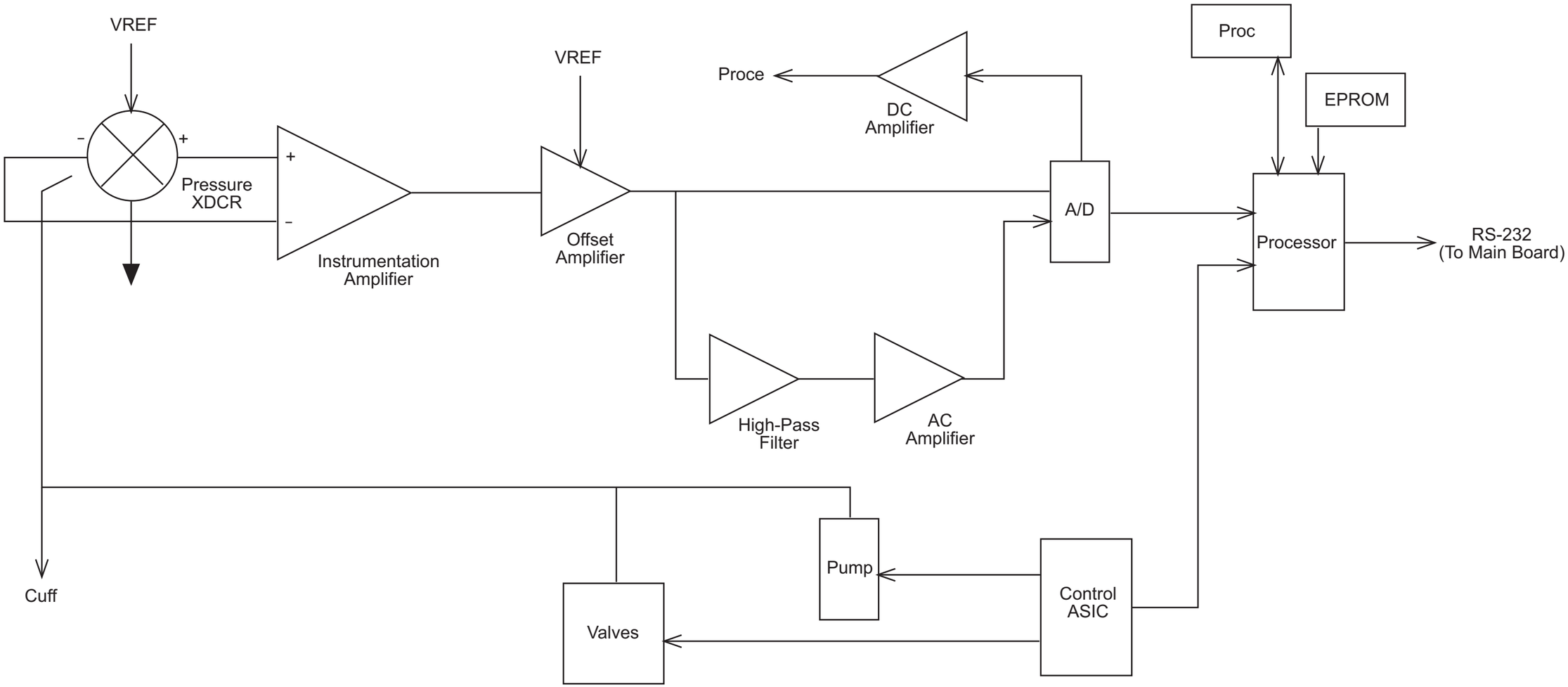
**DSP BOARD (1/2)
BLOCK DIAGRAM**



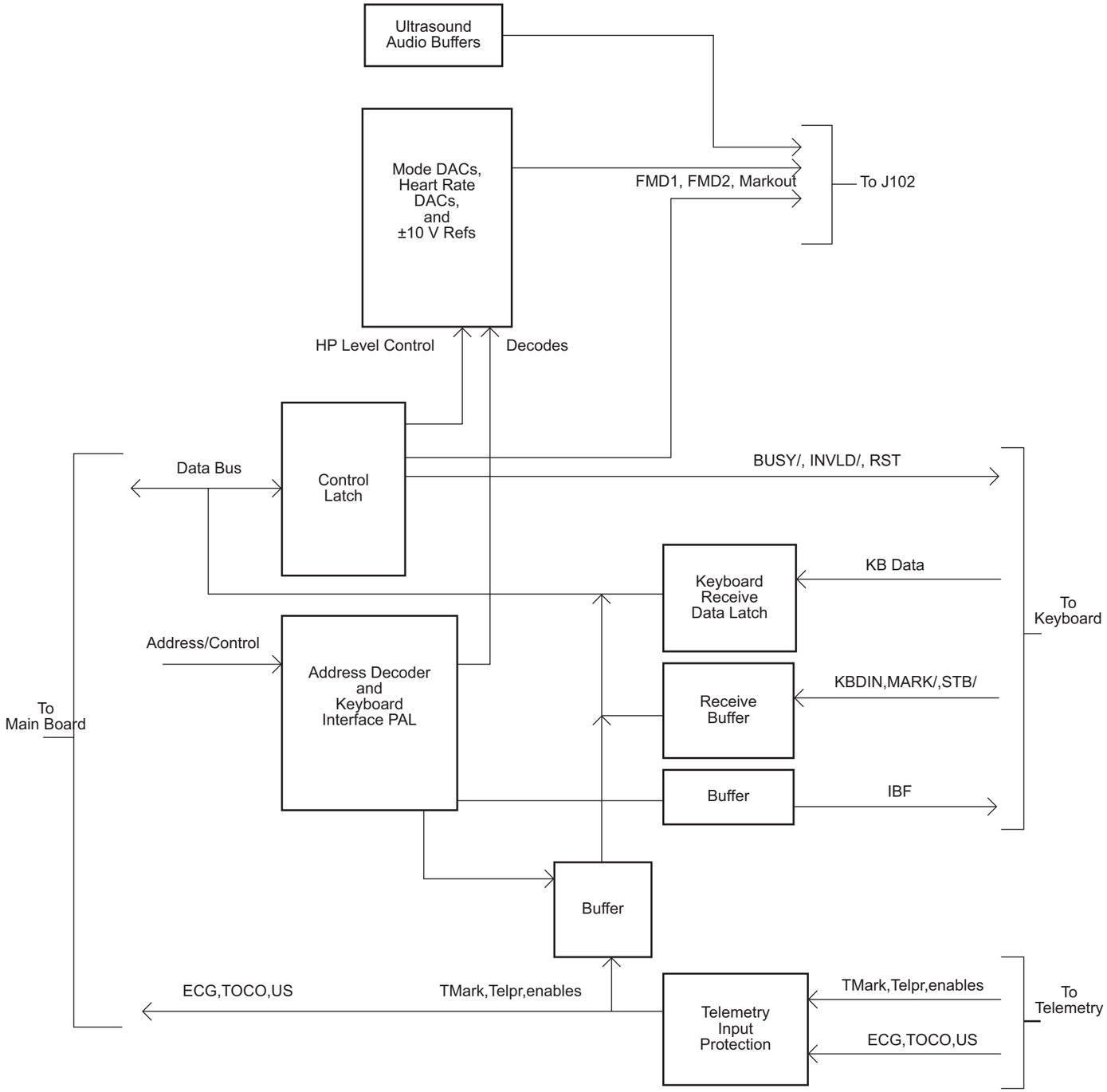
DSP BOARD (2/2)
BLOCK DIAGRAM



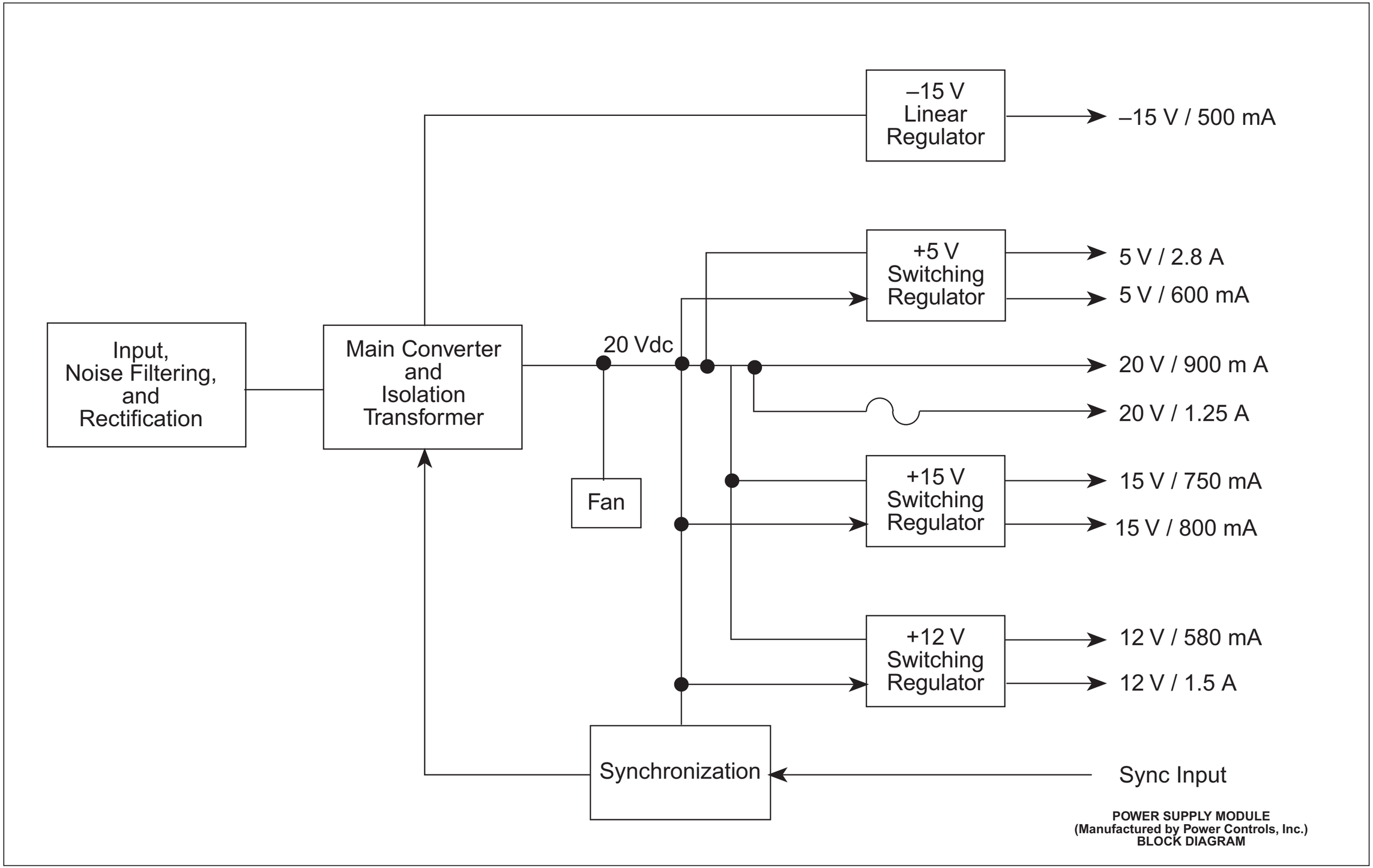
NBP MODULE
(Manufactured by CAS Medical Systems, Incorporated)
BLOCK DIAGRAM



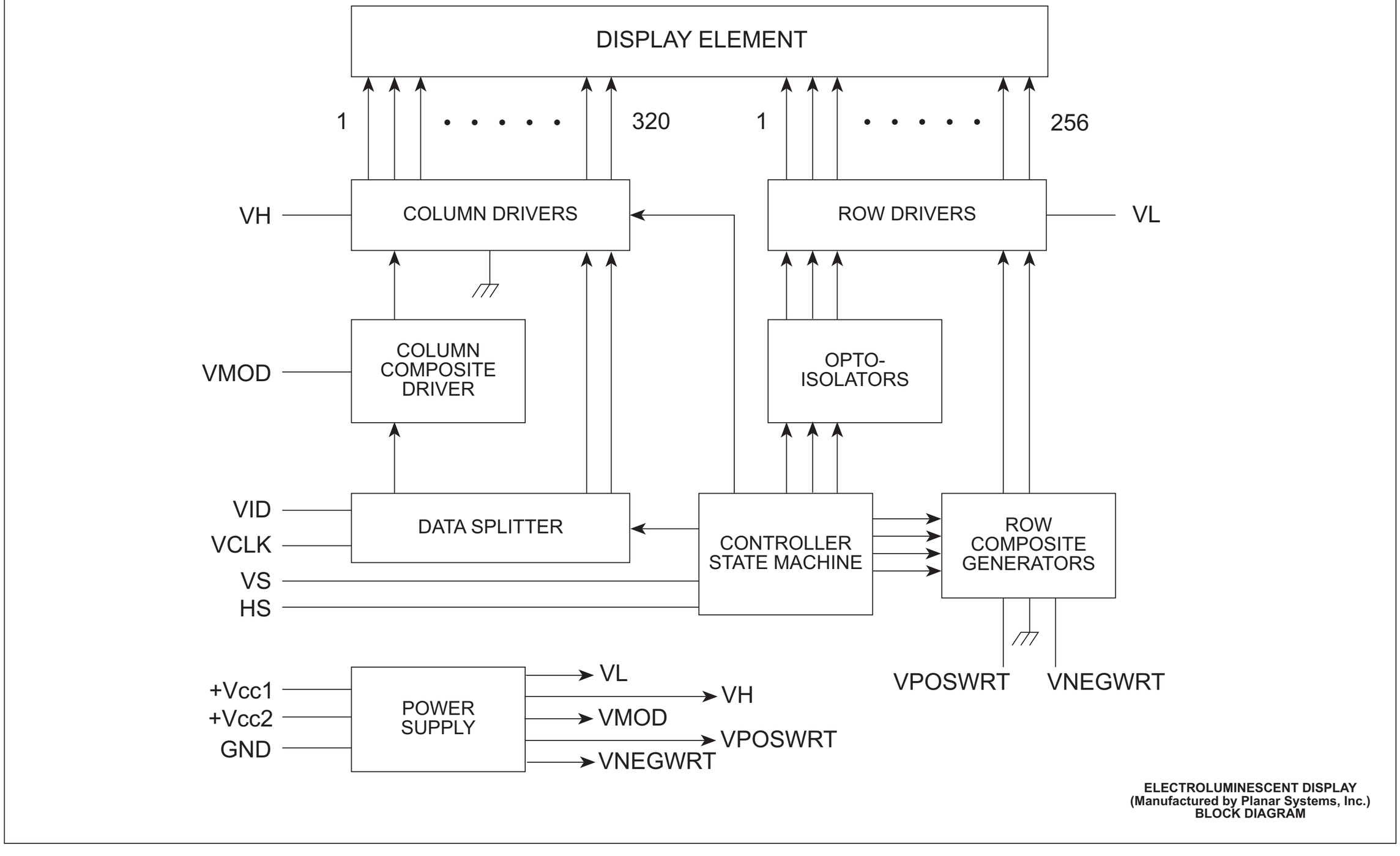
NBP MODULE
(Manufactured by Corometrics)
BLOCK DIAGRAM



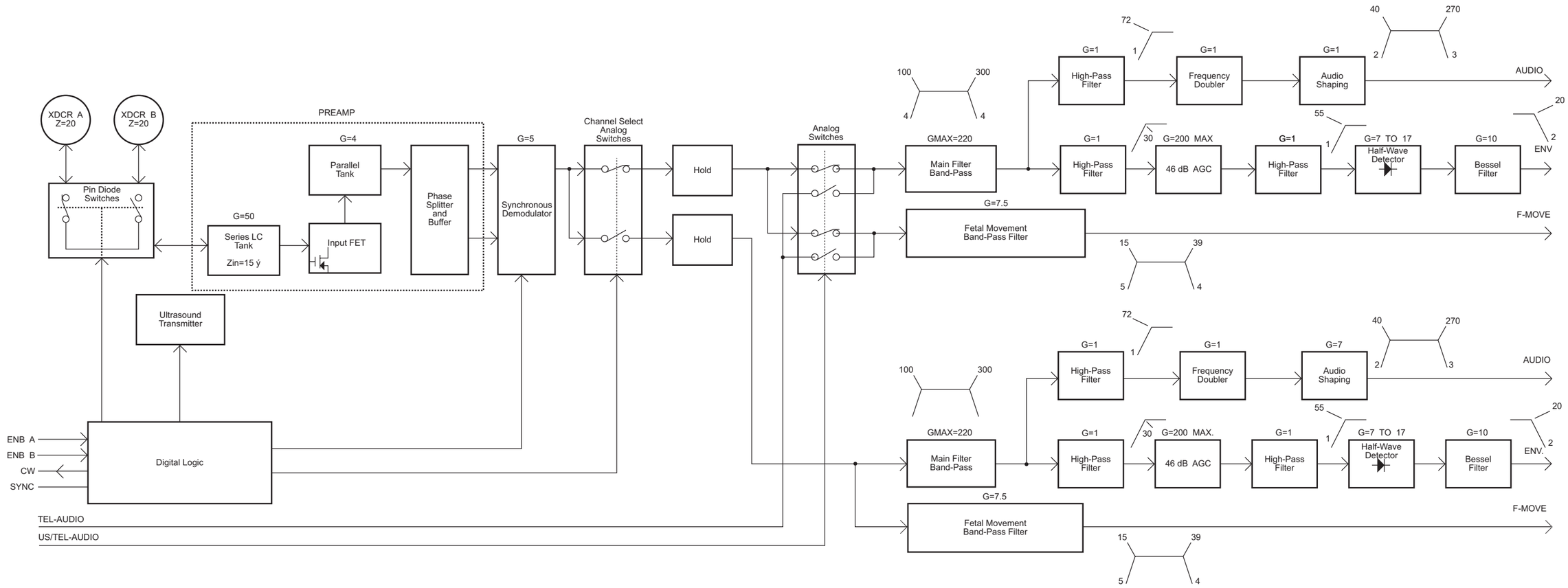
COMMUNICATIONS BOARD BLOCK DIAGRAM



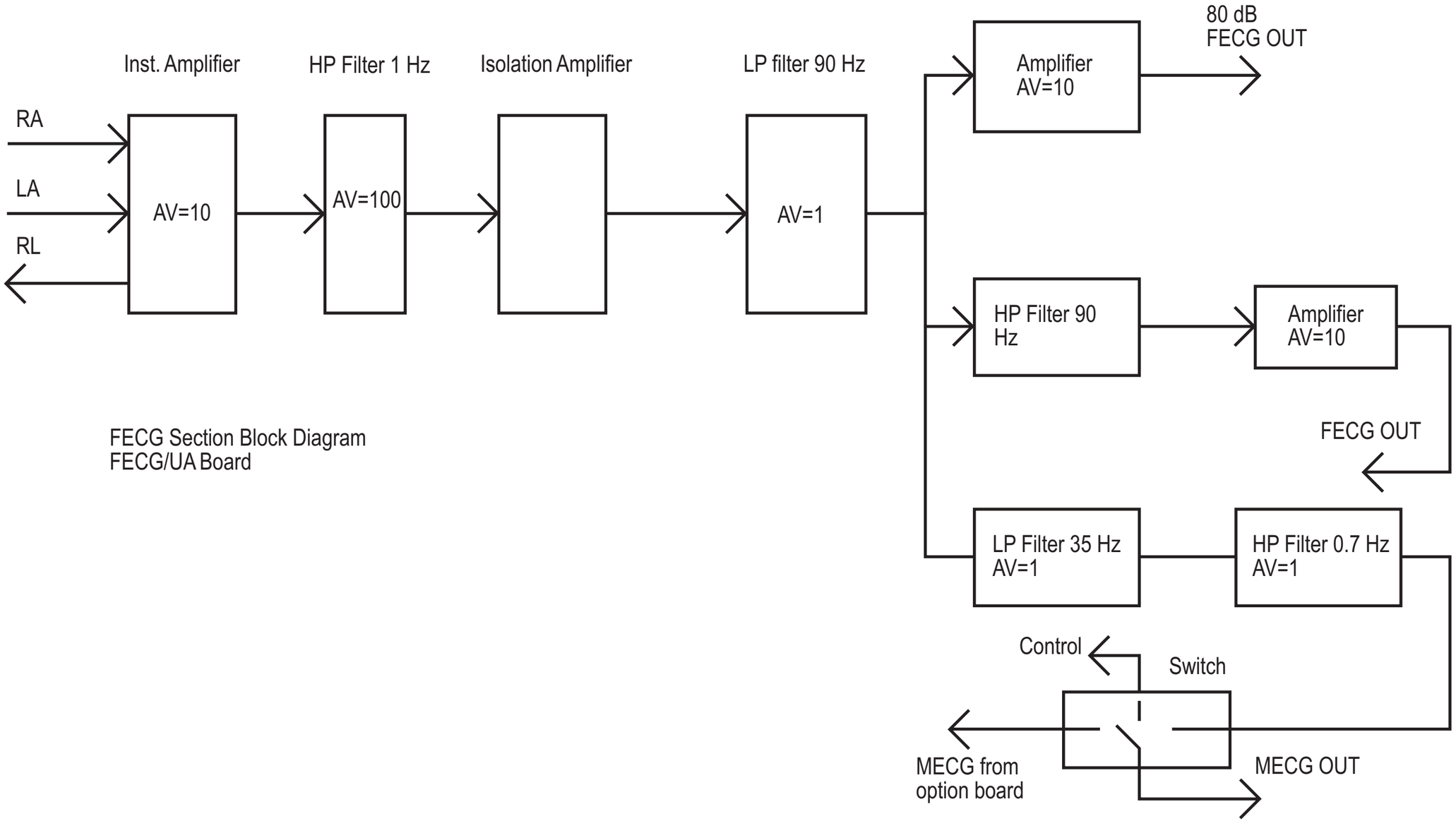
POWER SUPPLY MODULE
(Manufactured by Power Controls, Inc.)
BLOCK DIAGRAM



ELECTROLUMINESCENT DISPLAY
(Manufactured by Planar Systems, Inc.)
BLOCK DIAGRAM

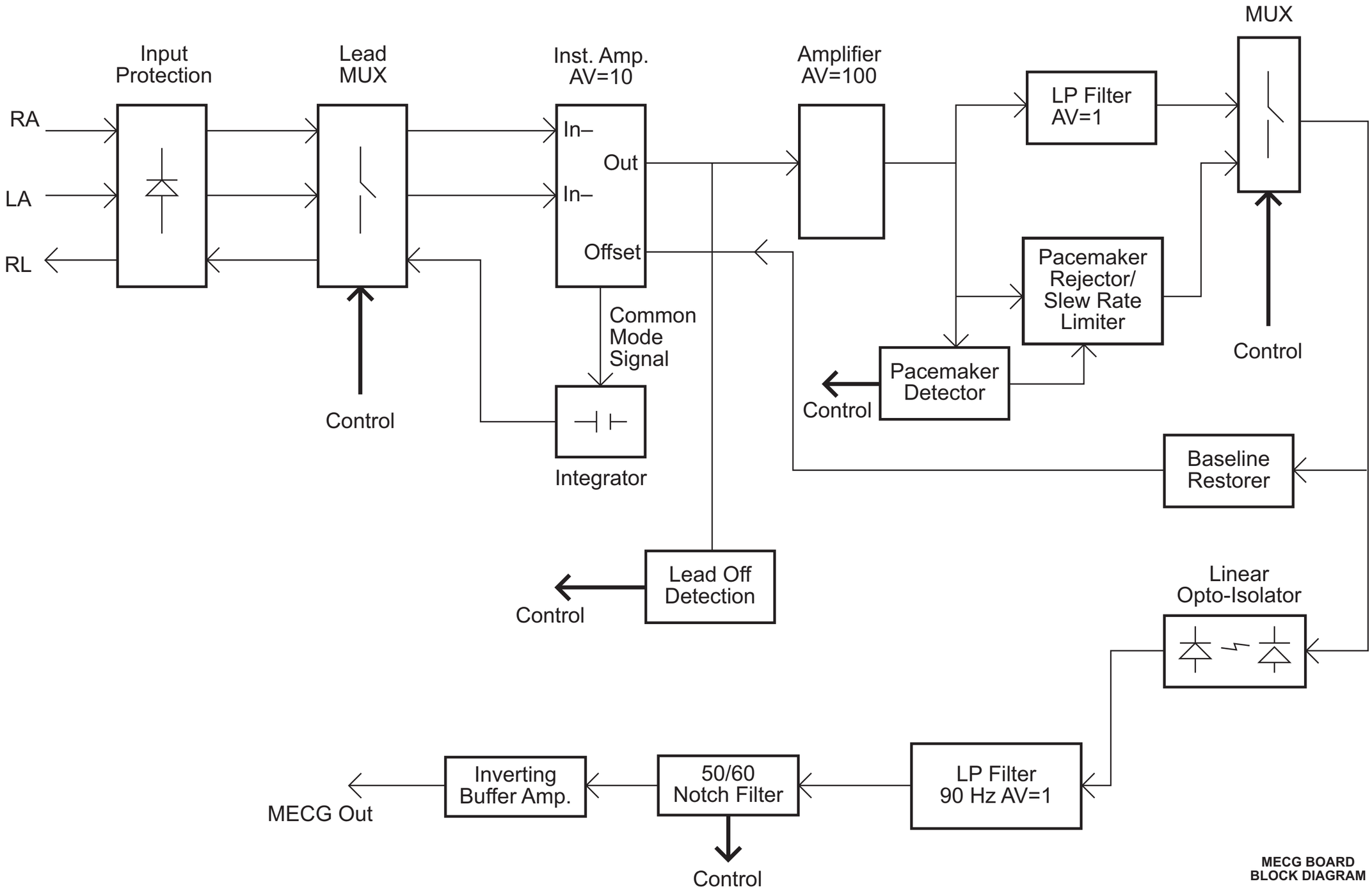


ULTRASOUND BOARD
BLOCK DIAGRAM

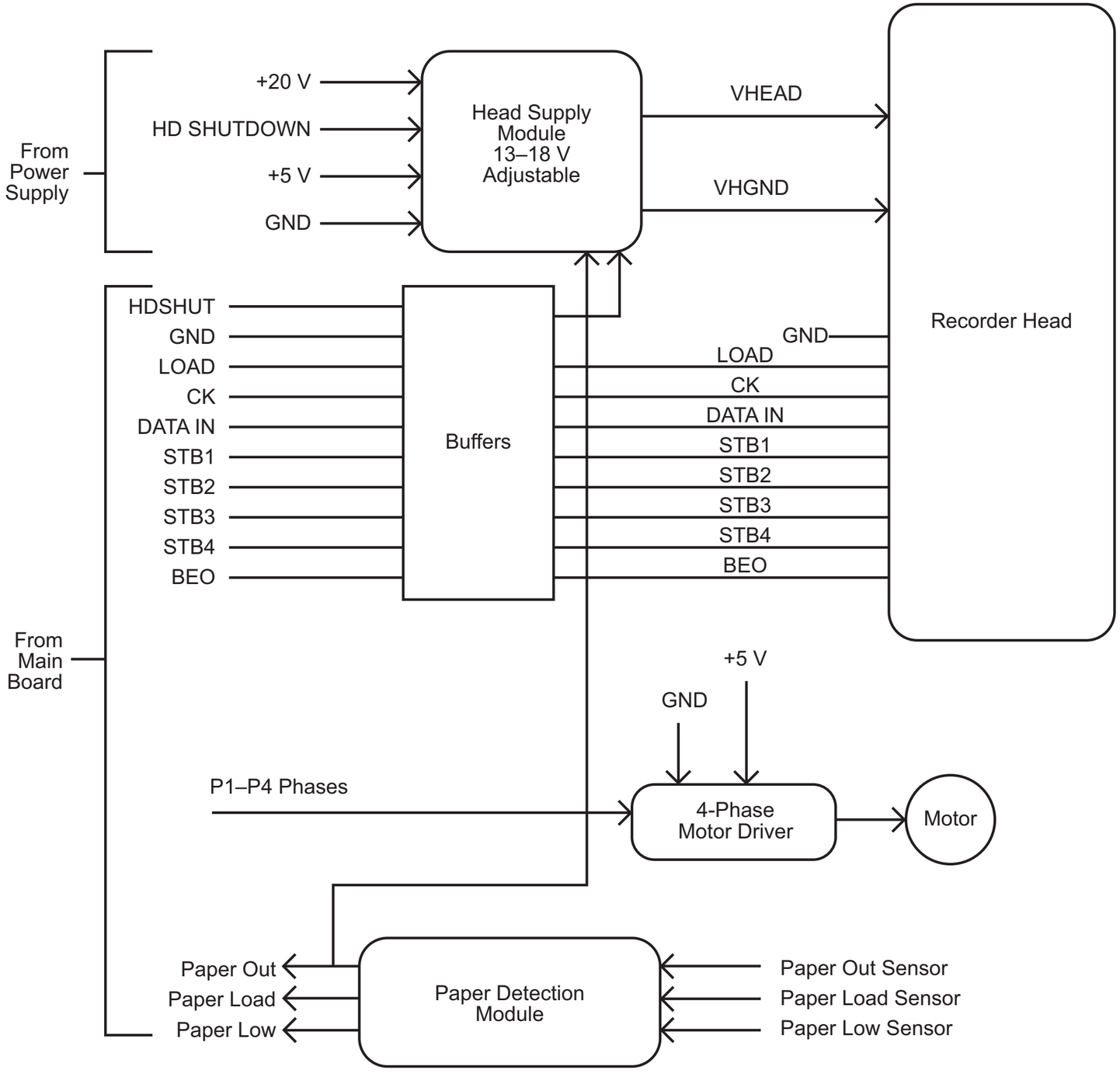


FECG Section Block Diagram
FECG/UA Board

FECG BOARD
BLOCK DIAGRAM



MECG BOARD BLOCK DIAGRAM



RECORDER BOARD BLOCK DIAGRAM

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